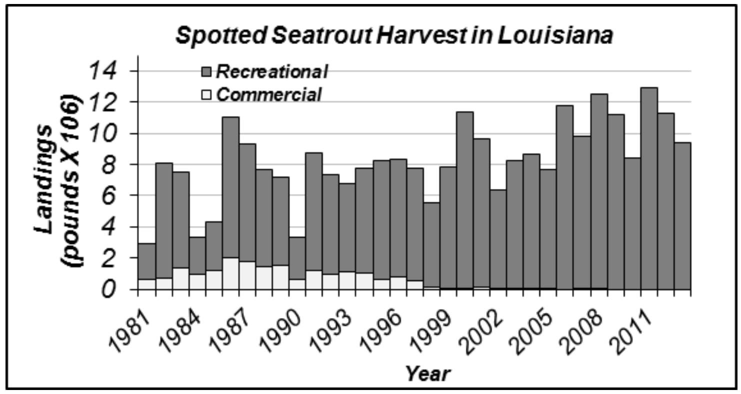
Update Assessment of Spotted Seatrout *Cynoscion nebulosus* in Louisiana Waters 2014 Report

Executive Summary

Landings of spotted seatrout (SST) in Louisiana have remained above 7 million pounds per year in the most recent decade. The highest recreational harvest on record (over 12 million pounds) was observed in 2011. After the commercial net ban in 1997, when rod and reel gear became the only allowed method of spotted seatrout harvest, commercial landings significantly declined. Nonetheless, recreational harvest of spotted seatrout in Louisiana has increased considerably over the time-series examined (1981-2013).



A statistical catch-at-age model is used in this stock assessment update to describe the dynamics of the female portion of the Louisiana spotted seatrout stock. The assessment model forward projects annual abundance at age from estimates of abundance in the initial year of the time-series and recruitment estimates in subsequent years. The model is fit to the data with a maximum likelihood fitting criterion. Minimum data requirements are fishery catch-at-age and an index of abundance. Landings are taken from the National Marine Fisheries Service (NMFS) Marine Recreational Fishing Statistical Survey (including the Marine Recreational Information Program), the Louisiana Department of Wildlife and Fisheries Trip Ticket Program, and the NMFS commercial statistical records. Abundance indices are developed from the LDWF experimental marine gillnet survey. Age composition of fishery catches are estimated with age-length keys derived from samples directly of the fishery and a von Bertalanffy growth function.

In earlier assessments of the LA SST stock (Blanchet *et al.* 1997), a conservation standard was established where "fishing mortality rates should not reduce the spawning potential of a cohort on average below 18% static SPR". This management benchmark was derived from the median spawning stock size in which the stock demonstrated sustainability (1979-1995). An analogous technique is used in this assessment to define targets and explicit limits of fishing, but changes in assessment methodology and data input require redefinition of the Louisiana spotted seatrout stock conservation standard.

Based on results of this assessment, targets and explicit limits of fishing are proposed as conservation standards to ensure future sustainability of the Louisiana spotted seatrout stock. Estimates of current stock status relative to the proposed limits indicate the stock is neither overfished nor experiencing overfishing. However, overfishing has occurred in the past.

Summary of Changes from 2011 Assessment

Assessment model inputs have been updated through 2013. No changes have been made to the assessment model itself.

Update Assessment of Spotted Seatrout *Cynoscion nebulosus* in Louisiana Waters
2014 Report

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1. Introduction

A statistical catch-at-age model is used in this stock assessment update to describe the dynamics of the female portion of the Louisiana (LA) spotted seatrout *Cynoscion nebulosus* (SST) stock from 1981-2013. The assessment model forward projects annual abundance at age from estimates of abundance in the initial year of the time-series and recruitment estimates in subsequent years. The model is fit to the data with a maximum likelihood fitting criterion. Minimum data requirements are fishery catch-at-age and an index of abundance (IOA). Commercial landings values are taken from the Louisiana Department of Wildlife and Fisheries (LDWF) Trip Ticket Program and the National Marine Fisheries Service (NMFS) commercial statistical records. Recreational harvest estimates are obtained from the NMFS Marine Recreational Fishing Statistical Survey/Marine Recreational Information Program (MRFSS/MRIP). Abundance indices are developed from the LDWF experimental marine gillnet survey. Age composition of fishery catches are estimated with age-length keys derived from samples directly of the fishery (2002-2013) and a von Bertalanffy growth function (1981-2001).

1.1 Fishery Regulations

The LA SST fishery is governed by the LA State Legislature, the Wildlife and Fisheries Commission, and the Department of Wildlife and Fisheries. Current recreational regulations are a 12 inch minimum length limit (MLL) and a 25 fish per day bag limit, with the exception of south-west Louisiana (from the Texas border to the Mermentau River) that is currently managed with a 15 fish per day bag limit. Commercial harvest is limited to rod and reel gear only, with a 14 inch MLL. Historic commercial and recreational SST fishery regulations were reviewed in the prior assessment report (West *et al.* 2011).

1.2 Trends in Harvest

Time-series of recreational and commercial landings are presented (Table 1, Figures 1 and 2). Trends in harvest were reviewed in the prior assessment report (West *et al.* 2011).

2. Data Sources

2.1 Fishery Independent

The LDWF fishery-independent marine gillnet survey is used in this assessment to develop abundance indices for use in the assessment model. Below is a brief description of this surveys methodology. Complete details can be found in LDWF (2002).

For sampling purposes, coastal Louisiana is currently divided into five LDWF coastal study areas (CSAs). The definitions of those CSAs are different from that found in the 2002 field procedures manual (LDWF 2002). Current CSA definitions are as follows: CSA 1 – Mississippi State line to South Pass of the Mississippi River (Pontchartrain Basin); CSA 3 – South Pass of the Mississippi River to Bayou Lafourche (Barataria Basin); CSA 5 – Bayou Lafourche to eastern shore of Atchafalaya Bay (Terrebonne Basin); CSA 6 – Atchafalaya Bay to western shore of Vermillion Bay (Vermillion/Teche/Atchafalaya Basins); CSA 7 – western shore of Vermillion Bay to Texas State line (Mermentau/Calcasieu/Sabine Basins). The LDWF Marine Fisheries Section conducts routine standardized sampling within each CSA as part of a long-term comprehensive monitoring program to collect life-history information and measure relative abundance/size distributions of recreationally and commercially important species. These include the experimental marine gillnet, trammel net, and beach seine surveys.

In this assessment, only the experimental marine gillnet survey is used. This survey is conducted with standardized design. Hydrological and climatological measurements are taken with each biological sample, including water temperature, turbidity, conductivity and salinity. Survey gear is a 750' monofilament gillnet comprised of five 150-foot panels of 1.0, 1.25, 1.5, 1.75, and 2.0 inch bar meshes. Samples are taken by 'striking' the net; where the net is set either parallel to the shore (or reef) or set in a crescent-shape. The vessel is then maneuvered both inside and outside of the net in gradually tightening circles a minimum of three times to force fish into the net. All captured SST are enumerated and a maximum of 30 randomly selected SST per mesh panel are collected for length measurements, gender determination, and maturity information. When more than 30 SST are captured per mesh panel, catch-at-size is derived as the product of total catch and proportional subsample-at-size.

2.2 Fishery Dependent

Commercial

Commercial SST landings are taken from NMFS commercial statistical records (1981-1998; NMFS 2013a) and the LDWF Trip Ticket Program (1999-2013). For aging purposes, annual landings are allocated into six-month seasons (*i.e.,* January-June and July-December). Because only limited seasonal landings data are available from earlier in the fishery, the monthly landings records that are available are pooled into time-periods of consistent regulation (1981- 1996 and 1997-1998) to develop seasonal catch compositions (Table 2). Starting in 1999, seasonal catches are taken directly from the LDWF trip ticket program.

Size composition of commercial catches in each year and season are derived from LDWF sampling effort (pre-1997) and MRFSS/MRIP (1997-present). Pre-1997 size distributions are only available for a limited number of years (1986 and 1990-1992) during which time the commercial sector operated under different MLLs and used a wider variety of harvest methods. Therefore, the 1990-1992 data are combined to describe the size composition of commercial catches from 1987- 1996 (*i.e.,* primarily a net fishery with a

14 inch MLL) and the 1986 data are used to describe the 1981-1986 commercial size compositions (*i.e.*, primarily a net fishery with 10 and 12 inch MLLs; **Error! Reference source not found.Error! Reference source not found.**Table 2). Seasonal size distributions of commercial catches are not available pre-1997; therefore, equivalent size composition is assumed for each six-month period. For years following the commercial net ban (*i.e*., 1997-present; only rod and reel harvest allowed with a 14 inch MLL), size composition of commercial catches are taken from MRFSS/MRIP (*i.e*., assuming equivalent vulnerability to rod and reel gear for both fisheries, but selecting only sizes ≥14 inches; Table 3).

Recreational

Recreational SST catches are derived from MRFSS/MRIP (NMFS 2013b). It's important to point out the recent change in estimation methodology for the MRFSS/MRIP survey. Catch estimates, starting in 2004, are now derived with MRIP estimation methods; earlier estimates are derived with MRFSS estimation methods. In the prior assessment (West *et al.* 2011), MRIP catch estimates were not available. Comparison of the 2004-2010 MRFSS estimates used in the prior assessment to the MRIP estimates used in this assessment shows no overall significant difference; however, some values (2006-2007) are 5-22% percent lower, and the remaining years are 1-10% higher than the MRFSS estimates.

For aging purposes, SST landings (Type A+B1 catch) and live releases (Type B2 catch) are derived in six-month periods described above. Live releases are further delineated as legal or sublegal with MRFSS catch disposition codes.

Size composition of Type A+B1 catch is derived from MRFSS/MRIP for each year and six-month season (Table 3); size composition of legal Type B2 catch is assumed equivalent. Size composition of sublegal Type B2 catch in each year and season is estimated by first assuming all sublegal discards as <12 inches. Some catch, however, is in fact legal sized, but coded as sublegal due to catches greater than the 25 fish creel limit. These catches (~8% of LA angler trips per year, 1987-2009; LDWF/MRFSS unpublished data) occur infrequently and are thus considered negligible for purposes of this assessment. Size composition of SST catches < 12 inches are pooled from the years prior to recreational MLL implementation and used as proxies of sublegal size composition after the 12" MLL was implemented in 1987.

3. Life History Information

3.1 Unit Stock Definition

Spotted seatrout occur in estuaries and near shore coastal habitat along the Atlantic and Gulf coasts from Cape Cod, Massachusetts, to the Bay of Campeche, Mexico (GSMFC 2001). Most of the harvest, however, is taken in the Gulf of Mexico (GOM) with the largest recreational harvest occurring in LA waters (**Error! Reference source not found.Error! Reference source not found.**Table 1, Figure 2).

Studies using mitochondrial DNA markers (Gold and Richardson 1998; Gold *et al.* 1999) have confirmed significant population substructuring across GOM SST populations. For the purpose of this assessment, the unit stock is defined as those female SST occurring in LA waters. This approach is consistent with the current statewide management strategy; although SST in south-west LA (from the Texas border to the Mermentau River) are managed with slightly different regulations (see *Regulations* section).

3.2 Morphometrics

Weight-length regressions for LA SST were developed by Weiting (1989). For the purpose of this assessment, only the female-specific relationship is used with weight calculated from size as:

$$W = 1.17\times10^{-5}(FL)^{2.97} \quad [1]$$

where W is whole weight in grams and FL is fork length in mm. Fish with only FL measurements available are converted to TL using a relationship provided by the Florida Fish and Wildlife Institute (personal communication from Joe O'Hop, July 2010) where:

$$TL = 1.0008\times FL + 0.6306 \quad [2]$$

3.3 Growth

Spotted seatrout exhibit differences in growth between males and females, with larger SST being predominantly female (Weiting 1989). The von Bertalanffy growth function (VBGF) developed in the previous assessment for female SST (West *et al.* 2011) is employed in this assessment with age calculated from size as:

$$TL_a = 650\times(1 - e^{-0.451(a+0.036)}) \quad [3]$$

where TL_a is TL-at-age in mm and years.

3.4 Sex Ratio

The probability of being female at a specific size is calculated with a logistic function developed in the previous assessment (West *et al.* 2011) as:

$$P_{fem,l} = \frac{1}{[1+e^{[-0.46(TL-10.04)]}]} \quad [4]$$

where $P_{fem,l}$ is the estimated proportion of females in 1 inch TL intervals. The minimum sex ratio-at-size is assumed as 50:50.

3.5 Fecundity/Maturity

Spotted seatrout are serial spawners where annual fecundity is seasonally indeterminate. To realistically estimate annual fecundity, the number of eggs spawned per batch and the number of batches spawned per season must be known. Consistent estimates of batch fecundity and spawning frequency are currently not available for the LA SST stock (Wieting 1989; Nieland *et al.* 2002); therefore, female spawning stock biomass (SSB) is used as a proxy for total egg production in this assessment. This may introduce bias if fecundity does not scale linearly with body weight (Rothschild and Fogarty 1989).

Female maturity at size is calculated with a logistic function developed in West *et al.* (2011) as:

$$P_{mat,TL} = \frac{1}{\left[1+e^{[-0.76(TL-7.7)]}\right]} \quad [5]$$

where $P_{mat,TL}$ is the estimated proportion of sexual mature female spotted seatrout in 1 inch TL intervals. Female maturity at age is then calculated by substituting equation [5] into equation [3].

3.6 Natural Mortality

Spotted seatrout can live to at least ten years of age (Weiting 1989). For purposes of this assessment, a value of constant M is assumed (0.3), but is allowed to vary with weight-at-age to calculate a declining natural mortality rate with age. This value of M is consistent with a stock where approximately 1.5% of the stock remains alive to 10 years of age (Hewitt and Hoenig 2005). Following SEDAR 12 (SEDAR 2006), the estimate is rescaled where the average mortality rate over ages vulnerable to the fishery is equivalent to the constant rate over ages as:

$$M_a = M \frac{nL(a)}{\sum_{a_c}^{a_{max}} L(a)} \quad [6]$$

where M is a constant natural mortality rate over exploitable ages a, a_{max} is the oldest age-class, a_c is the first fully-exploited age-class, and n is the number of exploitable ages. The Lorenzen curve as a function of age is calculated from:

$$L(a) = W_a^{-0.288} \quad [7]$$

where -0.288 is the allometric exponent estimated for natural ecosystems (Lorenzen 1996) and W_a is weight-at-age.

3.7 Discard Mortality

Reported SST discard mortality estimates are highly variable (~5-95%; Murphy *et al.* 1995; Stunz and McKee 2006; James *et al.* 2007; personal communication from Glenn Thomas, LDWF, July 2011). Results of these studies suggest the magnitude of post-release mortality as dependent on a number of factors including water quality, bait/hook type, anatomical hooking location, and angler skill-level. Spotted seatrout landings, however, are not directly separable into such components. Therefore, discard mortality is assumed constant in this assessment (10%). This rate is consistent with the overall rod-and-reel release mortality rates from the previously mentioned studies, *i.e.* 5, 11, 10 and 14%, respectively. For modeling purposes, stock losses due to discard mortalities are incorporated directly into recreational landings estimates (see *Catch at Age Estimation*).

3.8 Relative Productivity / Resilience

The key parameter in age-structured population dynamics models is the steepness parameter (h) of the stock-recruitment relationship. Steepness is defined as the ratio of recruitment levels when the spawning stock is reduced to 20% of its unexploited level relative to the unexploited level and determines the degree of compensation in the population (Mace and Doonan 1988). Populations with higher steepness values are more resilient to perturbation and if the spawning stock is reduced to levels where recruitment is impaired are more likely to recover sooner once overfishing has ended. Generally, this parameter is difficult to estimate due to a lack of contrast in spawning stock size (*i.e.,* data not available at both high and low levels of stock size) and is typically fixed or constrained during the model fitting process. Estimates of steepness are not available for spotted seatrout.

Productivity is a function of fecundity, growth rates, natural mortality, age of maturity, and longevity and can be a reasonable proxy for resilience. We characterize the relative productivity of LA SST based on life-history characteristics, following SEDAR 9, with a classification scheme developed at the FAO second technical consultation on the suitability of the CITES criteria for listing commercially-exploited aquatic species (FAO 2001; Table 4). Each life history characteristic (von Bertalanffy growth rate, age at maturity, longevity, and natural mortality rate) is assigned a rank (low=1, medium=2, and high=3) and then averaged to compute an overall productivity score. In this case, the overall productivity score is 2.75 for LA spotted seatrout indicating high productivity and resilience.

4. Abundance Index Development

Abundance indices are developed separately for each mesh panel of the LDWF experimental marine gillnet survey. Only those mesh panels with greater than 20% capture rates (on average) are included in index development. Stations not sampled regularly through time and less frequent ‘cold-month’ samples (*i.e.*, October –March) are also excluded. Catch per unit effort is defined as the number of female SST caught in each mesh panel per net sample. To reduce unexplained variability in catch rates unrelated to changes in abundance, each IOA was standardized using methods described below.

A delta lognormal approach (Lo *et al.* 1992; Ingram *et al.* 2010) is used to standardize female SST catch-rates in each year as:

$$I_y = c_y p_y \quad [8]$$

where c_y are estimated annual mean CPUEs of non-zero female SST catches assumed as lognormal distributions and p_y are estimated annual mean probabilities of female SST capture assumed as binomial distributions. The lognormal and binomial means and their standard errors are estimated with generalized linear models as least square means and back transformed. The lognormal model considers only samples in which SST were captured; the binomial model considers all samples. Each IOA is then computed from equation [8] using the estimated least-squares means with variances calculated from:

$$V(I_y) \approx V(c_y)p_y^2 + c_y^2 V(p_y) + 2c_y p_y \mathrm{Cov}(c,p) \quad [9]$$

where Cov$(c,p)\approx \rho_{c,p}\left[SE(c_y)SE(p_y)\right]$ and $\rho_{c,p}$ represents the correlation of c and p among years.

Because of the designed nature of the experimental marine gillnet survey, model development was rather straightforward. Variables considered in model inclusion were year, CSA, and sampling location. Because only 'warm' month samples (*i.e.*, April-September) are included, time of year was not considered in model inclusion. To determine the most appropriate models, we began the model selection process with a fully-reduced model that included only year as a fixed effect. More complex models were then developed including interactions and random effects and compared using AIC and log-likelihood values. All sub-models were estimated with the SAS generalized linear mixed modeling procedure (PROC GLIMMIX; SAS 2009). In the final sub-models, year was considered a fixed effect, CSA was considered a random block effect, and sampling locations within CSAs were considered random subsampling block effects.

Sample sizes, proportion positive samples, nominal CPUE, standardized index, and coefficients of variation of the standardized indices are presented (Table 5). Standardized and nominal CPUEs, normalized to 1 for comparison, are also presented (Figure 3).

5. Catch at Age Estimation

Age-length-keys (ALKs) are developed to estimate age composition/catch-at-age of fishery and survey catches as described below.

Spotted seatrout in LA exhibit a protracted spawning season, with spawning primarily occurring across a six-month period from April through September (Hein and Shepard 1980). The mid-point of the spawning season (July 1st) is typically assumed as a biological birthday. However, for purposes of this assessment, ages were assigned based on the calendar year by assuming a January 1st birthday, where SST spawned the previous year become age-1 on January 1st and remain age-1 until the beginning of the following year.

5.1 Fishery

Beginning in 2002, ALKs are developed from samples directly of the fishery; for earlier years, from the female von Bertalanffy growth function.

1981-2001 Probabilities of age a given length l in each six-month season (s; January-June and July-December) are computed as:

$$P(a|l)_s = \frac{P(l|a)_s}{\sum_a P(l|a)_s} \quad [10]$$

where the probability of length given age in each season is estimated from a normal probability density as:

$$P(l|a)_s = \frac{1}{\sigma_{as}\sqrt{2\pi}} \int_{l-d}^{l+d} e\left[-\frac{(l-l_{as})^2}{2\sigma_{as}^2}\right] dl$$

where length bins are 1 inch TL intervals with midpoint l, maximum $l + d$, and minimum $l - d$ lengths. Mean length-at-age in each season l_{as} is estimated from equation [3]. Variance in length-at-age is approximated as $\sigma_{as}^2 = l_{as}CV_l$, where the coefficient of variation in length-at-age CV_l is assumed constant (in this case 0.05). To approximate changes in growth during each season, mean length-at-age is calculated at the midpoint of each six month period relative to January 1st. Thus, two seasonal $P(a|l)_s$ matrices are developed to assign ages to female SST fishery landings from 1981-2001 (**Error! Reference source not found.Error! Reference source not found.**Table 6) and also for instances discussed below.

2002-2013 Probabilities of age given length for each year and six-month season are computed as:

$$P(a|l)_{yfs} = \frac{n_{lays}}{\sum_a n_{lays}} \quad [11]$$

where n_{lays} is female sample-size in each length/age bin in each year and six-month season (Table 8). When $\sum_a n_{lays} < 10$, the $P(a|l)$ for that 1 inch TL interval is estimated with equation [10].

Annual fishery-specific (f, recreational or commercial) catch-at-age (females only) is then calculated as:

$$C_{afy} = \sum_l \sum_s P_{fem,l} C_{lfys} P(a|l)_{ys} \quad [12]$$

where $P_{fem,l}$ is taken from equation [4], C_{lfy} is fishery-specific catch-at-size in each year and six-month season, and $P(a|l)_y$ are taken from equations [10 or 11]. Recreational discard mortalities are incorporated directly into the recreational harvest-at-age by applying a 10% discard mortality rate to estimated recreational releases-at-size and combining them with recreational harvest at size estimates. Resulting fleet-specific annual catch-at-age (including discard mortalities) and associated mean weights-at-age are presented (Tables 10-12).

5.2 Survey

Probabilities of age given length for female SST catches of the LDWF marine gillnet survey are computed from equation [10]. Mean length-at-age is estimated from equation [3]. Variance in length-at-age is approximated as $\sigma_{as}^2 = l_{as}CV_l$, where the coefficient of variation in length-at-age CV_l is assumed constant (in this case 0.05). To approximate changes in growth during the survey period (April-September), mean length-at-age is calculated at the midpoint of the six month survey period relative to January 1st. Resulting survey $P(a|l)$ is presented (Table 7). Annual survey female catch-at-age is then taken from equation [12] with annual gear-specific survey catch-at-size substituted. Resulting annual survey age compositions (females only) are presented (Table 9).

6. Assessment Model

In this assessment update, the Age-Structured Assessment Program (ASAP3 Version 3.0.12; NOAA Fisheries Toolbox http://nft.nefsc.noaa.gov) is used to describe the dynamics of the female proportion of the LA SST stock. ASAP is a statistical catch-at-age model that allows internal estimation of a Beverton-Holt stock recruitment relationship and MSY-related reference points. Minimum data requirements are fishery catch-at-age, corresponding mean weights-at-age, and a tuning index. ASAP projects abundance at age from estimates of abundance in the initial year of the time-series and recruitment estimates in subsequent years. The model is fit to the data with a maximum likelihood fitting criterion. An overview of the basic model configuration, equations, and their estimation, as applied in this assessment, are provided below. Specific details and full capabilities of ASAP can be found in the technical documentation (ASAP3; NOAA Fisheries Toolbox).

6.1 Model Configuration

For purposes of this assessment, the model is configured with annual time-steps (1981-2013) and a calendar year time-frame.

Mortality

Fishing mortality is assumed separable by age a, year y, and fishery f as:

$$F_{ayf} = v_{af}Fmult_{yf} \quad [13]$$

where v_{af} are age and fishery-specific selectivities and $Fmult_{yf}$ are annual fishery-specific apical fishing mortality rates. Apical fishing mortalities are estimated in the initial year and as deviations from the initial estimates in subsequent years.

Fishery-specific selectivities are modeled with double logistic functions as:

$$v_{af} = \left(\frac{1}{1+e^{-(a-\alpha_f)/\beta_f}}\right)\left(1 - \frac{1}{1+e^{-(a-\alpha 2_f)/\beta 2_f}}\right) \quad [14]$$

Total mortality for each age and year is estimated from the age-specific natural mortality rate M_a and the estimated fishing mortalities as:

$$Z_{ay} = M_a + \sum_f F_{ayf} \quad [15]$$

For reporting purposes, annual fishing mortalities are averaged by weighting by population numbers at age as:

$$F_y = \frac{\sum_a F_{ay} N_{ay}}{\sum_a N_{ay}} \quad [16]$$

Abundance

Abundance in the initial year of the time series and recruitment in subsequent years are estimated and used to forward calculate the remaining numbers at age from the age and year-specific total mortality rates as:

$$N_{ay} = N_{a-1,y-1} e^{-Z_{a-1,y-1}} \quad [17]$$

Numbers in the plus group A are calculated from:

$$N_{Ay} = N_{A-1,y-1} e^{-Z_{A-1,y-1}} + N_{A,y-1} e^{-Z_{A,t-1}} \quad [18]$$

Stock Recruitment

Expected recruitment is calculated from the Beverton-Holt stock recruitment relationship, reparameterized by Mace and Doonan (1988), with annual lognormal deviations as:

$$\hat{R}_{y+1} = \frac{\alpha SSB_y}{\beta + SSB_y} + e^{\delta_{y+1}} \quad [19]$$

$$\alpha = \frac{4\tau(SSB_0/SPR_0)}{5\tau - 1} \text{ and } \beta = \frac{SSB_0(1-\tau)}{5\tau - 1}$$

where SSB_0 is unexploited female spawning stock biomass, SPR_0 is unexploited spawning stock biomass per recruit, τ is steepness, and $e^{\delta_{y+1}}$ are annual lognormal recruitment deviations..

Spawning Stock

Female spawning stock biomass in each year is calculated from:

$$SSB_y = \sum_{i=1}^{A} N_{ay} W_{SSB,a}\, p_{mat,a} e^{-Z_{ay}(0.5)} \quad [20]$$

where $W_{SSB,a}$ are female spawning stock biomass weights-at-age, $p_{mat,a}$ is the proportion of mature females-at-age, and $-Z_{ay}(0.5)$ is the proportion of total mortality occurring prior to spawning on July 1st.

Catch

Expected fishery catches are estimated from the Baranov catch equation as:

$$\hat{C}_{ayf} = N_{ay} F_{ayf} \frac{(1-e^{-Z_{ay}})}{Z_{ay}} \quad [21]$$

Expected age composition of fishery catches are then calculated from $\frac{\hat{C}_{ayf}}{\sum_a \hat{C}_{ayf}}$. Expected fishery yields are computed as $\sum_a \hat{C}_{ayf} \overline{W}_{ayf}$, where $\overline{W}_{ayf}$ are observed mean catch weights.

Catch-rates

Expected survey catch-rates are computed from:

$$\hat{I}_{ay} = q \sum_a N_{ay} (1 - e^{-Z_{ay}(0.5)}) v_a \quad [22]$$

where v_a are survey selectivities, q are the estimated catchability coefficients, and $-Z_{ay}(0.5)$ is the proportion of the total mortality occurring prior to the time of the survey (July 1st midpoint). Survey selectivities are modeled with double logistic functions (equation [14]). Expected survey age composition is then calculated as $\frac{\hat{I}_{ay}}{\sum_a \hat{I}_{ay}}$.

Parameter Estimation

The number of parameters estimated is dependent on the length of the time-series, number of fisheries/selectivity blocks modeled, and the number of tuning indices modeled. Parameters are estimated in log-space and then back transformed. In this assessment, 140 parameters are estimated:

1. 32 selectivity parameters (5 blocks for the fisheries; 3 blocks for the surveys)
2. 66 apical fishing mortality rates (F_{mult} in the initial year and 32 deviations in subsequent years for 2 fisheries)
3. 33 recruitment deviations (1981-2013)
4. 5 initial population abundance deviations (age-2 through 6-plus)

5. 3 catchability coefficients (3 surveys)
6. 1 stock-recruitment parameter (SSB_0; the steepness parameter is fixed at 1.0 for the base run).

The model is fit to the data by minimizing the objective function:

$$-ln(L) = \sum_i \lambda_i(-ln\, L_i) + \sum_j(-ln\, L_j) \quad [23]$$

where – $ln(L)$ is the entire negative log-likelihood , lnL_i are log-likelihoods of lognormal estimations, λ_i are user-defined weights applied to lognormal estimations, and lnL_j are log-likelihoods of multinomial estimations.

Negative log-likelihoods with assumed lognormal error are derived (ignoring constants) as:

$$-ln(L_i) = 0.5 \sum_i \frac{[ln(obs_i) - ln(pred_i)]^2}{\sigma^2} \quad [24]$$

where obs_i and $pred_i$ are observed and predicted values; standard deviations σ are user-defined CVs as $\sqrt{ln(CV^2 + 1)}$.

Negative log-likelihoods with assumed multinomial error are derived (ignoring constants) as:

$$-ln(L_j) = -ESS \sum_{i=1}^{A} p_i\, ln(\hat{p}_i) \quad [25]$$

where p_i and $\hat{p}_i$ are observed and predicted age composition. Effective sample-sizes ESS are used to create the expected numbers $\hat{n}_a$ in each age bin and act as multinomial weighting factors.

6.2 Model Assumptions/Inputs

Model assumptions include: 1) the unit stock is adequately defined and closed to migration, 2) observations are unbiased, 3) errors are independent and their structures are adequately specified, 4) fishery and survey vulnerabilities are dome-shaped, 5) abundance indices are proportional to absolute abundance, and 6) natural mortality, growth and sex ratio at size/age do not vary significantly with time. Lognormal error is assumed for catches, abundance indices, the stock-recruitment relationship, apical fishing mortalities, selectivity parameters, initial abundance deviations, and catchabilities. Multinomial error is assumed for fishery and survey age compositions.

The base model was defined with an age-6 plus group, steepness fixed at 1.0, 5 fishery selectivity blocks, three survey selectivity blocks, and input levels of error and weighting factors as described below. Input levels of error for fishery landings were specified with CV's of 0.2 for each year of the time-series; annual recruitment deviations were specified with CV's of 0.5. Input levels of error for survey catch-rates were specified with CV's estimated from each IOA standardization (Table 5). Lognormal components included in the objective function were equally weighted (all lambdas=1). Input effective sample sizes

(ESS) for estimation of fishery and survey age compositions were specified equally for all years of the time-series (all ESS=200).

6.3 Model Results

Objective function components, weighting factors, and likelihood values of the base model are summarized in Table 13.

Model Fit

The base model provides an overall reasonable fit to the data. Model estimated catches match the observations well; however, patterning of the residuals is apparent in the recreational landings time-series where catches are generally over-estimated in earlier years and under-estimated in the more recent years (Figures 4 and 5). Model estimated survey catch-rates provide acceptable fits to the data, but fail to fit all extremes (Figures 6-8). Patterning of the residuals is also apparent, where catch-rates are generally over-estimated in more recent years suggesting a contradiction between data sources (*i.e.*, fishery landings vs. survey catch-rates). Model estimated fishery and survey age compositions provide reasonable fits to the input age proportions (Figures 9-11).

Selectivities

Estimated fishery and survey selectivities are presented in Figures 12 and 13. Survey estimates indicate full-vulnerability to the 1.0 and 1.25" mesh sizes at age-1 and full-vulnerability to the 1.5" mesh size at age-2. Commercial estimates indicate full-vulnerability at age-2 for each period of consistent regulation. Recreational estimates also indicate full-vulnerability at age -2 for each period of consistent regulation; however, age-1 vulnerabilities were reduced by approximately 50% after a 12" MLL was implemented in 1987.

Abundance, Recruitment, and Spawning Stock

Total stock size and abundance at age estimates from the base model are presented in Table 14. Total stock size has varied considerably over the time-series, while lacking an overall trend. Stock size decreased from 10.2 million females in 1981 to a minimum of 7.2 million females in 1984. Since 1984, stock size has increased. In each decade, total stock size peaks were observed in 1988 (17.7 million), 1999 (18.0 million), and 2000 (19.9 million). The 2013 estimate of female stock size is 14.7 million fish.

Estimates of age-1 recruitment follow comparable trends with total stock size with peaks occurring in the same years (Figure 14).

Female SSB estimates are presented in Figure 15. Female SSB has also varied over the time-series with an initial decline in earlier years to a minimum of 5.6 million pounds in 1990. Since 1990, female SSB has increased with peaks observed in 2000 (8.8 million pounds) and 2008 (9.6 million pounds). The 2013 estimate of female SSB is 7.2 million pounds.

Fishing Mortality

Estimated fishing mortality rates are presented in Table 15 (annual apical, average, and age-specific) and Figure 16 (average only). Average fishing mortality rates have varied considerably over the time-series, while lacking an overall trend. The highest estimates of average F were in earlier years of the time-series with peaks observed in 1983 (1.1 yr^{-1}) and 1989 (1.3 yr^{-1}). Since 1989, the trend in average fishing mortality has remained relatively flat with peaks observed in 1994 (0.87 yr^{-1}), 2001 (0.91 yr^{-1}), 2009 (0.80 yr^{-1}), and 2012 (0.91 yr^{-1}). The 2013 estimate of average F is 0.64 yr^{-1}.

Stock-Recruitment

No discernable relationship is observed between female spawning stock biomass and subsequent age-1 recruitment (Figure 17). The ASAP base model was run with steepness fixed at 1.0. The estimated unexploited female SSB was 68.2 million pounds. When allowed to directly solve for steepness, the parameter was estimated as 1.0. Alternate runs with steepness values fixed at 0.95, 0.90, 0.85, and 0.80 are discussed in the *Model Diagnostics* Section below.

Parameter Uncertainty

In the ASAP base model, 140 parameters were estimated. Asymptotic standard errors for the time-series age-1 recruits are presented in Figure 14. Markov Chain Monte Carlo derived confidence intervals (95%) for the average fishing mortality rate and spawning stock biomass time-series are presented in Figures 15 and 16.

6.4 Management Benchmarks

Overfishing and overfished limits should be defined for exploitable stocks. The implication is that when biomass falls below a specified limit, there is an unacceptable risk that recruitment will be reduced to undesirable levels. Management actions are needed to avoid approaching this limit and to recover the stock if biomass falls below the limit.

An examination of Figure 17 indicates no observed decline in recruitment over a range of spawning stock biomass. However, an option for a precautionary limit might be imposed by requiring that spawning stock biomass not fall below the lowest observed level. This would be equivalent to maintaining the stock above a limit spawning potential ratio (SPR; Goodyear, 1993). The method for calculating SPR_{limit} is presented below.

When the stock is in equilibrium, equation [20] can be solved, excluding the year index, for any given exploitation rate as:

$$\frac{SSB}{R}(F) = \sum_{i=1}^{A} N_a p_{mat,a} W_{SSB,a} e^{-Z_a(0.5)} \quad [29]$$

where total mortality at age Z_a is computed as $M_a + v_a Fmult$; vulnerability at age v_a is taken by rescaling the current F-at-age estimate (geometric mean 2011-2013) to the maximum. Per recruit abundance-at-age is estimated as $N_a = S_a$, where survivorship at age is calculated recursively from $S_a = S_{a-1}e^{-Z_a}$, $S_1 = 1$. Per recruit catch-at-age is then calculated with the Baranov catch equation [21], excluding the year index. Yield per recruit (Y/R) is then taken as $\sum_a C_a \bar{W}_a$ where $\bar{W}_a$ are current mean fishery weights at age (arithmetic mean 2011-2013). Fishing mortality is averaged by weighting by relative numbers at age.

Equilibrium spawning stock biomass SSB_{eq} is calculated by substituting SSB/R estimated from equation [29] into the Beverton-Holt stock recruitment relationship as $\alpha \times SSB/R - \beta$. Equilibrium recruitment R_{eq} and yield Y_{eq} are then taken as $SSB_{eq} \div SSB/R$ and $Y/R \times R_{eq}$. Equilibrium SPR (e.g., SPR_{limit}) is then computed as the ratio of SSB/R when F>0 to SSB/R when F=0.

As reference points to guide management, we estimate the spawning potential ratio and average fishing mortality rate that lead to the lowest SSB observed (SSB_{limit}, $SPR_{limit,}$ and F_{limit}). The targets of fishing should not be so close to the limits that the limits are exceeded by random variability of the environment. Therefore, we propose a SSB target as the median SSB in which the stock has demonstrated sustainability and estimate the SPR and F that lead to this target (SPR_{target} and F_{target}). This reference point system is intended to stabilize the spawning potential of the stock at the median levels in which sustainability has been demonstrated.

In the most recent ‘preference’ survey of LA marine recreational anglers (Kelso *et al.* 1994), 79% of spotted seatrout anglers preferred “current regulations”, 14% preferred catches of “more, smaller fish”, and only 7% preferred catches of “fewer, larger fish”. The targets of fishing proposed in this assessment (demonstrated as sustainable levels) are consistent with these results, in that the majority of anglers prefer the status quo, *i.e.*, current regulation and the resulting magnitude of catch. However, if angler preference changes towards more conservative management another target of fishing may be warranted.

The proposed limits and targets of fishing are presented in Figure 18 relative to each respective time-series. Also presented are a plot of the stock recruitment data, equilibrium recruitment, and diagonals from the origin intersecting R_{eq} at the minimum, median, and maximum SSB estimates of the time-series, corresponding with a minimum equilibrium SPR of 8%, a median of 11% and a maximum of 20% (Figure 19). Limit and target reference points are also presented in Table 16.

6.5 Model Diagnostics

Sensitivity Analysis

A series of sensitivity runs are used to explore uncertainty in the base model's configuration. The ASAP base model was run with steepness fixed at 1.0. Alternate runs were conducted examining reference point estimates with steepness fixed at 0.95, 0.90, 0.85 and 0.80. Additional sensitivity runs were conducted by separately up-weighting the contributions of catch and IOA components within the base models objective function (lambdas increased from 1 to 10). A final sensitivity run was conducted by incorporating the effects of cold-kills during the winters of 1983/1984 and 1989 by adjusting M at age relative to the overall proportional drop in catch rates from the experimental marine gillnet survey the year following the cold-kill.

Results of the sensitivity runs relative to the proposed limit reference points are presented in Table 17. Current estimates of female SSB and average F are taken as the geometric mean of 2011-2013 estimates. Estimates of F_{limit}, SSB_{limit}, and Y_{limit} for each sensitivity run were similar in magnitude (0.73-0.88 year^{-1}, 4.6-5.8 million pounds, and 5.6-7.0 million pounds respectively). Reference point estimates from all sensitivity runs indicate the stock is currently above SSB_{limit} and the fishery is currently operating below F_{limit}.

Also presented are estimates of maximum sustainable yield (MSY) and associated reference points for those sensitivity runs with the steepness parameter not fixed at 1(Table 18). Results of each run indicate that the fishery is currently operating past MSY, where ratios of current F and SSB to F_{MSY} and SSB_{MSY} are above and below 1 respectively. It's important to note, however, that the selection of specific values for the steepness parameter results in specified values of $SSB_{MSY,}$ $F_{MSY,}$ and other MSY statistics. Therefore, MSY values are not estimated per se, but are the results of the value selected for steepness.

Retrospective Analysis

A retrospective analysis was conducted by sequentially truncating the base model by a year (terminal years 2010-2013). Retrospective estimates of age-1 recruits, SSB and average fishing mortality differed from the base run (Figure 20). Terminal year estimates of age-1 recruits and female SSB indicate negative bias, where estimates increase as more years are added to the model. Terminal year estimates of average fishing mortality rates indicate positive bias, where estimates decrease as more years are added to the model.

7. Stock Status

The history of the LA SST stock relative to F/F_{limit} and SSB/SSB_{limit} is presented in Figure 18. Fishing mortality rates exceeding F_{limit} (F/F_{limit}>1.0) are defined as overfishing; spawning stock sizes below SSB_{limit} (SSB/SSB_{limit}< 1.0) are defined as the overfished condition. Current estimates of female SSB and average F are taken as the geometric mean of 2011-2013 estimates. The current estimate of equilibrium SPR is 10%.

Overfishing Status

The current estimate of F/F_{limit} is <1.0, suggesting the stock is currently not undergoing overfishing. However, the current assessment model indicates that the stock did experience overfishing in earlier years of the time-series.

Overfished Status

The current estimate of SSB/SSB_{limit} is >1.0, suggesting the stock is currently not in an overfished state.

Control Rules

There is currently no harvest control rule established for the LA SST stock.

8. Research and Data Needs

As with any analysis, the accuracy of this assessment is dependent on the accuracy of the information of which it is based. Below we list additional recommendations to improve future assessments of SST in Louisiana.

Assessment of regional or estuarine-specific spotted seatrout populations could differentiate exploitation rates and stock status within the state. If fine-scale spatial distribution data become available that allow for spatially-explicit assessment, results could be used to determine if regional management is an effective alternative to a statewide management strategy.

Spotted seatrout in south-west LA from the Texas border to the Mermentau River are currently managed with slightly different regulations than the remainder of the state. Again, if data become available that allow for spatially-explicit assessment, results could be used to determine if current management has altered exploitation/stock status in the south-west region and, if so, used as a framework for future management.

The relationship between wetlands losses and the continuation of fishery production within Louisiana has been discussed by numerous authors. Understanding this relationship as it applies to the LA SST stock should be an ongoing priority.

This assessment highlights differing trends between fishery-independent catch-rates and fishery dependent data sources. These differences should be evaluated further to determine which trends are truly reflective of population abundance, or whether other factors (e.g., increasing harvest efficiencies, changing vulnerabilities of the stock, etc.) are involved.

Only limited age data are available from the LDWF marine gillnet survey. Ages of survey catches in this assessment were assigned from a von Bertalanffy growth function. Age samples collected directly from the survey in question would allow a more accurate representation of survey age composition in future assessments.

Factors that influence year-class strength of spotted seatrout are poorly understood. Investigation of these factors, including inter-annual variation in seasonal factors and the influence of environmental perturbations such as the Deepwater Horizon oil spill, could elucidate causes of inter-annual variation in abundance, as well as the species stock-recruitment relationship.

Existing LA estimates of batch fecundity and spawning frequency are conflicting. Additional estimates are needed.

An updated preference survey of LA marine recreational fishers would allow objective determination of ‘current’ angler preference.

Fishery-dependent data alone is not a reliable source of information to assess status of a fish stock. Consistent fishery-dependent and fishery-independent data sources, in a comprehensive monitoring plan, are essential to understanding the status of fishery. A new LDWF fishery-independent survey methodology was implemented in 2013. This methodology should be assessed for adequacy with respect to its ability to evaluate stock status, and modified if deemed necessary.

With the recent trend toward ecosystem-based assessment models (Mace 2000; NMFS 2001), more data is needed linking spotted seatrout population dynamics to environmental conditions. The addition of meteorological and physical oceanographic data coupled with food web data may lead to a better understanding of the spotted seatrout stock and its habitat.

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10. Tables

Table 1: Louisiana annual commercial and recreational spotted seatrout landings (pounds x 10^6) derived from NMFS statistical records, LDWF trip ticket program, and MRFSS/MRIP. Recreational landings are A+B1 catches only.

	Harvest			
Year	Commercial	Recreational	%Commercial	%Recreational
1981	0.59	2.34	20	80
1982	0.73	7.37	9	91
1983	1.34	6.20	18	82
1984	0.97	2.37	29	71
1985	1.16	3.17	27	73
1986	1.98	9.11	18	82
1987	1.80	7.50	19	81
1988	1.43	6.29	19	81
1989	1.49	5.70	21	79
1990	0.65	2.68	19	81
1991	1.22	7.55	14	86
1992	0.97	6.38	13	87
1993	1.14	5.64	17	83
1994	1.02	6.71	13	87
1995	0.66	7.57	8	92
1996	0.77	7.59	9	91
1997	0.55	7.22	7	93
1998	0.11	5.43	2	98
1999	0.08	7.80	1	99
2000	0.04	11.33	0	100
2001	0.11	9.56	1	99
2002	0.07	6.26	1	99
2003	0.02	8.22	0	100
2004	0.02	8.64	0	100
2005	0.02	7.68	0	100
2006	0.00	11.77	0	100
2007	0.01	9.78	0	100
2008	0.01	12.53	0	100
2009	0.00	11.20	0	100
2010	0.00	8.44	0	100
2011	0.00	12.95	0	100
2012	0.00	11.28	0	100
2013	0.00	9.38	0	100

Table 2: Louisiana commercial size and season compositions of spotted seatrout landings derived from NMFS statistical records, LDWF commercial landings records, and the LDWF trip ticket program.

Size Comp, 1981-1996		
TL_in	1981-1986	1987-1996
10	1	
11	12	
12	80	3
13	166	61
14	276	347
15	304	441
16	146	384
17	89	316
18	47	172
19	39	81
20	23	42
21	10	16
22	11	7
23	7	5
24	11	1
25	3	1
26	1	1
27		

Season Comp, 1981-2013		
Year	January-June	July-December
1981-1996	0.55	0.45
1997-1998	0.88	0.12
1999	0.90	0.10
2000	0.55	0.45
2001	0.90	0.10
2002	0.88	0.12
2003	1.00	0.00
2004	1.00	0.00
2005	1.00	0.00
2006	1.00	0.00
2007	1.00	0.00
2008	1.00	0.00
2009	1.00	0.00
2010	1.00	0.00
2011	1.00	0.00
2012	1.00	0.00
2013	0.00	1.00

Table 3: Annual size frequency distributions of Louisiana recreational spotted seatrout harvest (January-June; A+B1 catches only) from MRFSS/MRIP.

Recreational, January-June 1981-1997																	
TL_in	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
6		0.01															
7	0.01	0.00	0.00	0.01			0.01										
8		0.05	0.00		0.03	0.02	0.01								0.00		
9	0.02	0.05	0.04	0.01	0.02	0.04	0.02										
10	0.10	0.07	0.07	0.04	0.16	0.10	0.10	0.00			0.01	0.00	0.00	0.00	0.00	0.00	0.01
11	0.30	0.12	0.13	0.24	0.19	0.13	0.18	0.03	0.01	0.08	0.06	0.06	0.05	0.09	0.09	0.07	0.06
12	0.11	0.13	0.14	0.36	0.24	0.24	0.17	0.21	0.07	0.18	0.23	0.22	0.28	0.26	0.28	0.18	0.17
13	0.06	0.10	0.19	0.07	0.13	0.09	0.14	0.31	0.27	0.19	0.21	0.27	0.26	0.22	0.21	0.23	0.24
14	0.09	0.08	0.18	0.12	0.05	0.15	0.17	0.16	0.26	0.21	0.13	0.21	0.14	0.16	0.13	0.19	0.21
15	0.01	0.06	0.10	0.06	0.02	0.06	0.12	0.10	0.15	0.13	0.14	0.11	0.08	0.09	0.10	0.08	0.11
16	0.09	0.03	0.02	0.06	0.05	0.06	0.05	0.04	0.08	0.09	0.10	0.05	0.03	0.07	0.06	0.12	0.08
17	0.08	0.04	0.02		0.05	0.06	0.01	0.06	0.06	0.04	0.06	0.03	0.05	0.05	0.04	0.03	0.05
18	0.06	0.09	0.02	0.02	0.03	0.02	0.01	0.02	0.03	0.05	0.02	0.01	0.04	0.02	0.02	0.04	0.04
19	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.03	0.03	0.01	0.01	0.01	0.03	0.02	0.03	0.04	0.01
20	0.03	0.03	0.05		0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
21		0.02	0.02		0.02	0.01	0.00	0.02	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00
22	0.05	0.03	0.01		0.00		0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.01	0.00
23		0.02	0.01			0.00	0.00		0.00		0.00	0.00	0.00	0.00	0.00		0.01
24		0.02				0.00			0.00			0.00			0.00		
25		0.03			0.00							0.00	0.00		0.00		0.00
26		0.00															
27		0.00							0.00								
28		0.00															
29		0.00															
30																	

Recreational, January-June 1998-2013																
TL_in	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
6																
7			0.00													
8	0.00	0.00		0.00											0.00	
9	0.00							0.00								
10		0.01	0.00	0.00	0.00	0.00	0.00		0.00		0.00	0.00				0.00
11	0.05	0.05	0.04	0.02	0.05	0.05	0.06	0.05	0.05	0.04	0.05	0.04	0.04	0.03	0.05	0.09
12	0.18	0.21	0.19	0.18	0.16	0.16	0.24	0.20	0.14	0.16	0.20	0.19	0.13	0.15	0.16	0.15
13	0.22	0.22	0.20	0.18	0.14	0.18	0.19	0.23	0.16	0.23	0.22	0.28	0.14	0.26	0.16	0.18
14	0.26	0.17	0.18	0.18	0.16	0.21	0.15	0.22	0.22	0.16	0.20	0.22	0.19	0.19	0.14	0.21
15	0.09	0.11	0.11	0.11	0.16	0.13	0.13	0.13	0.16	0.11	0.11	0.10	0.16	0.14	0.16	0.15
16	0.06	0.09	0.12	0.08	0.11	0.07	0.07	0.08	0.12	0.09	0.07	0.06	0.11	0.08	0.13	0.07
17	0.05	0.04	0.05	0.07	0.07	0.05	0.06	0.04	0.06	0.07	0.05	0.06	0.09	0.06	0.08	0.05
18	0.04	0.02	0.04	0.08	0.05	0.05	0.05	0.02	0.04	0.05	0.04	0.03	0.04	0.04	0.04	0.03
19	0.02	0.03	0.03	0.04	0.04	0.05	0.02	0.01	0.02	0.04	0.02	0.01	0.04	0.01	0.02	0.03
20	0.01	0.02	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.05	0.02	0.03	0.01
21	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.02	0.01
22	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01		0.01	0.00	0.00	0.01	0.00	0.00	
23		0.00	0.00	0.00	0.01	0.01	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.01	
24		0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00		0.00
25		0.00		0.00		0.00	0.00						0.00	0.00		
26							0.00			0.00					0.00	
27		0.00									0.00					
28													0.00			
29																
30																

Table 3 (cont.): Annual size frequency distributions of Louisiana recreational spotted seatrout harvest (July-December; A+B1 catches only) from MRFSS/MRIP.

	Recreational, July-December 1981-2013																
TL_in	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*
4		0.00			0.00												
5		0.00			0.00					0.00							
6		0.00			0.00			0.00									
7		0.01	0.00		0.00	0.00							0.01				
8		0.02	0.00	0.00	0.02	0.01	0.00					0.00	0.00	0.00	0.00	0.00	
9	0.01	0.04	0.01	0.03	0.04	0.10	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
10	0.01	0.04	0.04	0.03	0.13	0.19	0.08	0.00	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01
11	0.14	0.12	0.14	0.08	0.12	0.18	0.14	0.02	0.02	0.05	0.07	0.05	0.09	0.07	0.07	0.06	0.07
12	0.31	0.18	0.11	0.12	0.20	0.18	0.20	0.12	0.11	0.23	0.29	0.31	0.27	0.26	0.27	0.17	0.30
13	0.16	0.24	0.18	0.11	0.20	0.12	0.18	0.27	0.25	0.22	0.30	0.22	0.24	0.26	0.24	0.24	0.24
14	0.23	0.16	0.23	0.15	0.14	0.09	0.18	0.19	0.23	0.16	0.13	0.17	0.15	0.15	0.16	0.18	0.15
15	0.04	0.05	0.11	0.07	0.08	0.05	0.11	0.13	0.14	0.11	0.10	0.09	0.09	0.10	0.11	0.10	0.07
16	0.06	0.04	0.09	0.07	0.03	0.04	0.05	0.11	0.09	0.10	0.05	0.06	0.06	0.05	0.04	0.10	0.05
17	0.02	0.02	0.02	0.00	0.00	0.02	0.03	0.07	0.06	0.06	0.04	0.04	0.04	0.04	0.05	0.06	0.05
18	0.03	0.03	0.06	0.18	0.01	0.01	0.01	0.03	0.04	0.02	0.01	0.02	0.01	0.02	0.01	0.04	0.02
19	0.00	0.02	0.00	0.03	0.00	0.00	0.00	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.02
20		0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.01
21		0.00		0.05		0.00	0.00	0.01	0.00		0.00	0.00	0.00	0.00	0.00	0.01	0.00
22		0.00	0.00	0.05		0.00		0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
23		0.00	0.00	0.03		0.00		0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
24		0.00				0.00		0.00	0.00				0.00		0.00	0.00	0.00
25				0.00							0.00			0.00	0.00		
26				0.00									0.00	0.00	0.00		
27						0.00						0.00					
28																	
29																	
30																	

	Recreational, July-December 1981-2013															
TL_in	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*
4																
5																
6																
7																
8	0.01								0.00					0.00		
9	0.00		0.00	0.00				0.00	0.00	0.00	0.00				0.00	0.00
10	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
11	0.08	0.07	0.05	0.05	0.04	0.08	0.09	0.08	0.07	0.07	0.06	0.07	0.05	0.03	0.06	0.05
12	0.27	0.29	0.24	0.24	0.26	0.31	0.28	0.31	0.29	0.27	0.23	0.27	0.29	0.17	0.25	0.26
13	0.21	0.21	0.21	0.20	0.23	0.21	0.23	0.21	0.22	0.27	0.24	0.23	0.30	0.20	0.23	0.28
14	0.17	0.16	0.14	0.15	0.17	0.14	0.19	0.16	0.17	0.16	0.20	0.15	0.16	0.19	0.16	0.17
15	0.09	0.08	0.10	0.12	0.11	0.10	0.09	0.10	0.09	0.09	0.12	0.11	0.10	0.15	0.10	0.09
16	0.07	0.07	0.09	0.09	0.08	0.05	0.04	0.05	0.06	0.06	0.07	0.08	0.05	0.09	0.07	0.07
17	0.04	0.06	0.05	0.06	0.04	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.02	0.05	0.06	0.04
18	0.03	0.03	0.04	0.04	0.03	0.02	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.04	0.03	0.02
19	0.02	0.02	0.03	0.02	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.04	0.02	0.01
20	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.01
21	0.01	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	
22	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
24		0.00	0.00	0.00	0.00	0.00			0.00	0.00	0.00	0.00		0.00	0.00	0.00
25		0.00			0.00	0.00	0.00			0.00	0.00	0.00		0.00	0.00	
26			0.00		0.00	0.00								0.00	0.00	
27						0.00										
28																
29																
30																

Table 4: FAO proposed guidelines for indices of productivity for exploited fish species.

Parameter	***Productivity***			***Species***	
	Low	***Medium***	***High***	*Spotted Seatrout*	***Score***
M	*<0.2*	*0.2 - 0.5*	*>0.5*	***0.3***	*2*
K	*<0.15*	*0.15 - 0.33*	*>0.33*	***0.45***	*3*
tmat	*>8*	*3.3 - 8*	*<3.3*	***2***	*3*
tmax	*>25*	*14 - 25*	*<14*	***10***	*3*
Examples	*orange roughy, many sharks*	*cod, hake*	*sardine, anchovy*	***Spotted Seatrout Productivity Score = 2.75 (high)***	

Table 5: Annual sample size, proportion positive samples, nominal CPUE, index of abundance, and corresponding coefficients of variation derived from the LDWF fishery-independent marine gillnet survey. Nominal cpue and the index of abundance have been normalized to their individual long-term means for comparison.

	1.0" mesh					***1.25" mesh***					***1.5" mesh***				
Year	*n*	*% Positive*	*CPUE*	*Index*	*CV*	*n*	*% Positive*	*CPUE*	*Index*	*CV*	*n*	*% Positive*	*CPUE*	*Index*	*CV*
1986	487	0.41	0.93	1.16	0.29	--	--	--	--	--	487	0.22	0.89	0.64	0.28
1987	475	0.33	0.95	0.88	0.32	--	--	--	--	--	475	0.31	0.95	1.05	0.25
1988	413	0.39	1.19	1.34	0.29	413	0.49	1.20	1.69	0.22	413	0.41	1.12	1.87	0.21
1989	466	0.36	1.11	1.17	0.30	464	0.47	1.01	1.37	0.24	465	0.31	1.14	1.39	0.24
1990	477	0.32	0.97	0.84	0.32	477	0.38	0.93	0.92	0.27	477	0.24	0.99	0.79	0.27
1991	465	0.36	1.35	1.34	0.29	464	0.40	1.32	1.35	0.25	464	0.27	1.24	1.08	0.25
1992	460	0.33	1.30	1.12	0.31	460	0.41	1.24	1.33	0.25	460	0.33	1.22	1.59	0.23
1993	453	0.36	1.08	1.07	0.30	452	0.42	1.32	1.38	0.25	451	0.29	1.30	1.32	0.24
1994	478	0.36	1.08	1.06	0.30	478	0.38	1.11	1.03	0.27	477	0.27	1.06	1.05	0.25
1995	498	0.36	1.18	1.16	0.30	498	0.39	1.09	1.02	0.26	498	0.27	1.13	1.03	0.25
1996	496	0.33	0.93	0.88	0.31	496	0.43	0.99	1.11	0.25	496	0.28	1.07	1.12	0.25
1997	496	0.34	0.95	0.86	0.32	496	0.34	1.10	0.86	0.28	496	0.29	1.02	1.12	0.25
1998	485	0.35	0.95	0.92	0.31	485	0.36	1.09	0.93	0.27	485	0.25	1.09	0.96	0.26
1999	496	0.40	1.02	1.19	0.29	496	0.39	1.22	1.15	0.26	496	0.31	1.15	1.33	0.24
2000	504	0.38	0.85	0.95	0.30	504	0.44	1.11	1.29	0.24	504	0.35	1.08	1.55	0.22
2001	504	0.27	0.83	0.58	0.35	504	0.32	0.99	0.70	0.29	504	0.26	1.01	0.98	0.25
2002	496	0.33	0.78	0.72	0.33	496	0.35	0.87	0.73	0.29	496	0.22	0.84	0.65	0.28
2003	503	0.31	0.90	0.72	0.33	503	0.28	0.97	0.58	0.31	503	0.20	0.85	0.58	0.29
2004	503	0.32	0.85	0.76	0.32	503	0.30	0.96	0.64	0.30	503	0.22	0.87	0.66	0.28
2005	456	0.39	1.04	1.21	0.29	456	0.38	1.05	0.97	0.27	456	0.22	0.85	0.67	0.28
2006	495	0.38	0.97	1.10	0.29	494	0.38	1.10	1.01	0.27	495	0.30	0.94	1.10	0.25
2007	504	0.36	1.06	1.13	0.30	504	0.38	0.97	0.91	0.27	504	0.25	0.96	0.90	0.26
2008	490	0.36	1.15	1.19	0.30	490	0.37	1.08	0.99	0.27	490	0.24	0.85	0.76	0.27
2009	504	0.35	0.94	0.93	0.31	504	0.33	1.13	0.83	0.28	504	0.27	0.99	0.99	0.25
2010	439	0.29	0.92	0.83	0.33	439	0.27	1.00	0.65	0.31	439	0.18	0.78	0.51	0.30
2011	463	0.33	0.96	0.82	0.32	464	0.33	1.02	0.71	0.29	464	0.25	0.82	0.74	0.27
2012	477	0.32	0.79	0.70	0.33	477	0.35	1.01	0.77	0.29	477	0.22	0.88	0.68	0.28
2013	624	0.34	1.01	1.35	0.27	624	0.33	1.00	1.07	0.25	624	0.19	0.92	0.91	0.25

Table 6: Probabilities of age given length used in age assignments of spotted seatrout landings 1981-2001 (females only).

Fishery Landings 1981-2001 (January-June)						
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*
10	1.00	0.00	0.00	0.00	0.00	0.00
11	1.00	0.00	0.00	0.00	0.00	0.00
12	1.00	0.00	0.00	0.00	0.00	0.00
13	0.26	0.74	0.00	0.00	0.00	0.00
14	0.00	1.00	0.00	0.00	0.00	0.00
15	0.00	1.00	0.00	0.00	0.00	0.00
16	0.00	1.00	0.00	0.00	0.00	0.00
17	0.00	0.88	0.11	0.00	0.00	0.00
18	0.00	0.11	0.87	0.02	0.00	0.00
19	0.00	0.00	0.91	0.08	0.00	0.00
20	0.00	0.00	0.62	0.33	0.04	0.01
21	0.00	0.00	0.15	0.56	0.19	0.11
22	0.00	0.00	0.01	0.33	0.29	0.37
23	0.00	0.00	0.00	0.08	0.22	0.70
24	0.00	0.00	0.00	0.01	0.09	0.90
25	0.00	0.00	0.00	0.00	0.03	0.97
26	0.00	0.00	0.00	0.00	0.01	0.99
27	0.00	0.00	0.00	0.00	0.00	1.00
28	0.00	0.00	0.00	0.00	0.00	1.00

Fishery Landings 1981-2001 (July-December)						
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*
10	1.00	0.00	0.00	0.00	0.00	0.00
11	1.00	0.00	0.00	0.00	0.00	0.00
12	1.00	0.00	0.00	0.00	0.00	0.00
13	1.00	0.00	0.00	0.00	0.00	0.00
14	1.00	0.00	0.00	0.00	0.00	0.00
15	0.96	0.04	0.00	0.00	0.00	0.00
16	0.04	0.96	0.00	0.00	0.00	0.00
17	0.00	0.99	0.01	0.00	0.00	0.00
18	0.00	0.94	0.05	0.00	0.00	0.00
19	0.00	0.55	0.43	0.02	0.00	0.00
20	0.00	0.06	0.78	0.13	0.02	0.01
21	0.00	0.00	0.51	0.33	0.09	0.07
22	0.00	0.00	0.13	0.36	0.21	0.29
23	0.00	0.00	0.01	0.17	0.21	0.61
24	0.00	0.00	0.00	0.04	0.12	0.84
25	0.00	0.00	0.00	0.01	0.05	0.94
26	0.00	0.00	0.00	0.00	0.02	0.98
27	0.00	0.00	0.00	0.00	0.00	1.00
28	0.00	0.00	0.00	0.00	0.00	1.00

Table 7: Probabilities of age given length used in age assignments of spotted seatrout catches of the LDWF marine experimental gillnet survey (females only).

Survey Catches (April-September)						
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*
10	1.00	0.00	0.00	0.00	0.00	0.00
11	1.00	0.00	0.00	0.00	0.00	0.00
12	1.00	0.00	0.00	0.00	0.00	0.00
13	1.00	0.00	0.00	0.00	0.00	0.00
14	0.92	0.08	0.00	0.00	0.00	0.00
15	0.00	1.00	0.00	0.00	0.00	0.00
16	0.00	1.00	0.00	0.00	0.00	0.00
17	0.00	0.98	0.01	0.00	0.00	0.00
18	0.00	0.76	0.24	0.00	0.00	0.00
19	0.00	0.09	0.86	0.05	0.00	0.00
20	0.00	0.00	0.77	0.20	0.03	0.01
21	0.00	0.00	0.34	0.44	0.13	0.08
22	0.00	0.00	0.05	0.37	0.25	0.33
23	0.00	0.00	0.00	0.13	0.22	0.66
24	0.00	0.00	0.00	0.02	0.11	0.87
25	0.00	0.00	0.00	0.00	0.04	0.96
26	0.00	0.00	0.00	0.00	0.01	0.99
27	0.00	0.00	0.00	0.00	0.00	1.00
28	0.00	0.00	0.00	0.00	0.00	1.00

Table 8: Length at age samples used in age assignments of spotted seatrout landings 2002-2013 (females only).

2002 (January-June)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10							0
11							0
12	5	1					6
13	6	6					12
14	1	16					17
15		22	1				23
16	1	14	6				21
17		8	10				18
18		4	5				9
19			6	1			7
20		1	4	2			7
21			4				4
22							0
23							0
24							0
25							0
26							0
27							0
28							0
Total	13	72	36	3	0	0	124

2002 (July-December)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10							0
11							0
12	25	5	1				31
13	54	5		1			60
14	64	8	2				74
15	41	10	2				53
16	18	19	1				38
17	7	18	4				29
18	2	15	8				25
19	1	4	6	1			12
20		3	3				6
21		1	1				2
22		1	2				3
23					1		1
24							0
25							0
26							0
27							0
28							0
Total	212	89	30	2	1	0	334

2003 (January-June)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10							0
11	2						2
12	10	11	1				22
13	5	45	2				52
14	2	48	5	1			56
15		48	4				52
16		51	6				57
17		32	10				42
18		11	9	2	1		23
19		2	11	2			15
20		1	9	5	2		17
21			7	3			10
22			2	3	1		6
23				4	1		5
24			1	1			2
25				1			1
26							0
27							0
28							0
Total	19	249	67	22	5	0	362

2003 (July-December)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10							0
11	2						2
12	57	10					67
13	119	15	2				136
14	75	25					100
15	41	31	1		1		74
16	15	41	1				57
17	3	41					44
18		22	5				27
19		8	2				10
20		4	9				13
21		1	6				7
22		1	3	1			5
23			1				1
24				3			3
25						1	1
26				1		2	3
27							0
28					1		1
Total	312	199	30	5	2	3	551

2004 (January-June)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10							0
11							0
12	4	32	1				37
13	6	62	2	2			72
14		77					77
15		79					79
16		39	8				47
17		18	8				26
18		7	12	1			20
19		3	13				16
20			8	1	1	1	11
21			1	4	1		6
22				1	1		2
23		1		2			3
24						1	1
25							0
26							0
27							0
28							0
Total	10	318	53	11	3	2	397

2004 (July-December)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10							0
11	2						2
12	59	6	1				66
13	110	25					135
14	91	30	1				122
15	44	33	1			1	79
16	19	34	3				56
17	4	29	3				36
18		18	5	1			24
19		7	7				14
20		1	4	1			6
21		2	2				4
22					2		2
23				2			2
24			2			1	3
25					1		1
26							0
27							0
28							0
Total	329	185	29	4	3	2	552

Table 8 (continued):

2005 (January-June)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10							0
11							0
12	10	15					25
13	12	55	2				69
14	4	105	4	1			114
15		129	6		1		136
16		57	4				61
17		31	11				42
18		9	9				18
19		5	16	1			22
20		1	14				15
21			13		1		14
22			7				7
23			1				1
24				4			4
25						1	1
26							0
27				1		1	2
28							0
Total	26	407	87	7	2	2	531

2005 (July-December)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10							0
11	1						1
12	37	2					39
13	69	9	1				79
14	48	20					68
15	37	31					68
16	12	33	3				48
17	5	34	3				42
18	1	15	2				18
19		5	2				7
20		2	3				5
21			5	2	1		8
22			1	1			2
23			1				1
24			1				1
25							0
26							0
27							0
28							0
Total	210	151	22	3	1	0	387

2006 (January-June)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10							0
11	3						3
12	17	11	1				29
13	17	77	2				96
14	3	140	2				145
15	1	141	5				147
16	1	79	9				89
17		28	12				40
18		15	15	1			31
19		4	11				15
20		1	11	2			14
21			8				8
22			8				8
23			1	1			2
24				1			1
25							0
26							0
27							0
28							0
Total	42	496	85	5	0	0	628

2006 (July-December)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10							0
11							0
12	40	2					42
13	103	8	3				114
14	75	33					108
15	39	70					109
16	9	40	1				50
17	5	43	2				50
18	1	25	4				30
19		11	1	1			13
20		6	1				7
21			4				4
22		1		1			2
23		2	1				3
24							0
25							0
26							0
27							0
28							0
Total	272	241	17	2	0	0	532

2007 (January-June)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10							0
11	1						1
12	9	11	1				21
13	4	49	2				55
14		89	1				90
15		101	7				108
16		80	18	2			100
17		29	29				58
18		16	21	3			40
19		8	13	1			22
20		3	14	3	1		21
21			4	1			5
22			4	3	1		8
23			3	1			4
24					1		1
25							0
26							0
27							0
28							0
Total	14	386	117	14	3	0	534

2007 (July-December)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10							0
11	2						2
12	71	8					79
13	110	23	1				134
14	91	39	3				133
15	47	70	4	1			122
16	13	57	1				71
17	3	57	4	1			65
18	2	29	9				40
19	1	14	7				22
20		4	2	2			8
21			5	1			6
22			5				5
23			1	1			2
24							0
25			1				1
26							0
27							0
28							0
Total	340	301	43	6	0	0	690

Table 8 (continued):

2008 (January-June)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10	1						1
11		1					1
12	19	40	2				61
13	5	104	2				111
14	1	106	4				111
15		87	19	1			107
16		56	24				80
17		15	34				49
18		10	31	1			42
19		3	26	1	1		31
20		1	7	4			12
21			9	3			12
22			4	1			5
23			2				2
24					1		1
25					1		1
26							0
27							0
28							0
Total	26	423	164	11	3	0	627

2008 (July-December)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10							0
11	1						1
12	78	12	3				93
13	145	41	5				191
14	109	71	6	1			187
15	69	68	3	1			141
16	28	64	7				99
17	4	38	9				51
18	1	28	13				42
19		8	14				22
20		3	15	3	1		22
21		4	8	2			14
22			2	3			5
23							0
24			1				1
25			1		1		2
26							0
27							0
28							0
Total	435	337	87	10	2	0	871

2009 (January-June)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10							0
11		1					1
12	21	39	1	2			63
13	4	109	6	2			121
14	1	138	4	1			144
15	2	92	16				110
16		42	18	1			61
17		30	20	2			52
18		7	29	4			40
19		4	17	3	1		25
20		1	16	6			23
21			10	3			13
22			4	2			6
23			1	4			5
24				7			7
25				2	1		3
26							0
27							0
28							0
Total	28	463	142	39	2	0	674

2009 (July-December)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10							0
11	2						2
12	56	9	2				67
13	121	30	3				154
14	104	52	4				160
15	55	71	4				130
16	28	66	5				99
17	6	52	2				60
18	4	28	13	2			47
19		12	7	1			20
20		5	7	2			14
21			9	1			10
22			6	4			10
23			4	3			7
24				1	2		3
25			1	3			4
26							0
27			1				1
28							0
Total	376	325	68	17	2	0	788

2010 (January-June)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10							0
11							0
12	12	18	1				31
13	6	57	4	1			68
14	1	89	3	1			94
15		88	1				89
16		55	12	1			68
17		28	18	2			48
18		9	23	2			34
19			18	2			20
20			12	3			15
21			4	1			5
22				1			1
23			2	1			3
24				1			1
25							0
26							0
27							0
28							0
Total	19	344	98	16	0	0	477

2010 (July-December)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10							0
11	1	1					2
12	69	5					74
13	152	18	2				172
14	127	26	4				157
15	55	41	3	1			100
16	13	32	4				49
17	3	33	1				37
18	1	21	2				24
19		6	3				9
20			1	2			3
21		1	1				2
22			2		1		3
23				3			3
24							0
25							0
26							0
27							0
28							0
Total	421	184	23	6	1	0	635

Table 8 (continued):

2011 (January-June)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10		1					1
11		1					1
12	12	8					20
13	28	38	2				68
14	13	66	10	1			90
15	3	109	8				120
16		80	10				90
17		52	16				68
18		10	19				29
19		2	20				22
20		1	3				4
21			4	1			5
22				1			1
23							0
24						1	1
25				1			1
26					1		1
27							0
28							0
Total	56	368	92	4	1	1	522

2011 (July-December)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10							0
11	3						3
12	70	9					79
13	119	12	2				133
14	123	15	2				140
15	66	42	1				109
16	36	51	1				88
17	6	53	7				66
18	3	30	12	1			46
19		8	6	2			16
20	1	5	6	1			13
21	1	1	2	4			8
22			1	1			2
23							0
24							0
25							0
26							0
27							0
28							0
Total	428	226	40	9	0	0	703

2012 (January-June)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10							0
11	1						1
12	41	17	2				60
13	41	65	10				116
14	10	114	14	2			140
15	2	209	9	1			221
16	1	173	9	1			184
17		111	20	1			132
18		46	43	4			93
19		16	37	2	1	1	57
20		2	23	7	1		33
21			13	1			14
22		1	4	4			9
23			1	1			2
24					1		1
25				2			2
26							0
27							0
28							0
Total	96	754	185	26	3	1	1065

2012 (July-December)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10							0
11							0
12	35	3					38
13	66	8	1				75
14	75	11	2				88
15	31	7	2				40
16	14	15					29
17	4	21	2		1		28
18		17	1				18
19		8	2				10
20		8	1	1			10
21			1	1			2
22							0
23							0
24							0
25							0
26							0
27							0
28							0
Total	225	98	12	2	1	0	338

2013 (January-June)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10							0
11							0
12	18	39	2				59
13	14	119	5				138
14	4	168	7				179
15		158	2				160
16		101	1	1			103
17		57	4				61
18		22	12				34
19		5	16	1			22
20		2	18				20
21			7	2			9
22		1	2	2	1		6
23							0
24							0
25							0
26							0
27							0
28							0
Total	36	672	76	6	1	0	791

2013 (July-December)							
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6+*	*Total*
10	1						1
11	3	1					4
12	159	12					171
13	222	19					241
14	151	31	1				183
15	84	42	1				127
16	30	43		1			74
17	8	30					38
18	8	16	2	1			27
19	1	5	1				7
20			1				1
21			2				2
22		1					1
23							0
24							0
25							0
26							0
27							0
28							0
Total	667	200	8	2	0	0	877

Table 9: Annual survey age composition and sample sizes (female SST) derived from the LDWF experimental marine gillnet survey.

	1.0" mesh							1.25" mesh						
Year	n	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6+	n	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6+
1986	560	0.98	0.02	0.00	0.00	0.00	0.00	--	--	--	--	--	--	--
1987	541	0.96	0.04	0.00	0.00	0.00	0.00	--	--	--	--	--	--	--
1988	622	0.95	0.04	0.01	0.00	0.00	0.00	1064	0.90	0.09	0.01	0.00	0.00	0.00
1989	570	0.90	0.09	0.01	0.00	0.00	0.00	860	0.82	0.17	0.01	0.00	0.00	0.00
1990	486	0.93	0.05	0.01	0.00	0.00	0.00	710	0.83	0.16	0.00	0.00	0.00	0.00
1991	801	0.92	0.08	0.00	0.00	0.00	0.00	1132	0.86	0.14	0.00	0.00	0.00	0.00
1992	681	0.92	0.08	0.01	0.00	0.00	0.00	1078	0.81	0.18	0.01	0.00	0.00	0.00
1993	571	0.92	0.07	0.01	0.00	0.00	0.00	1070	0.87	0.12	0.00	0.00	0.00	0.00
1994	616	0.91	0.08	0.01	0.00	0.00	0.00	865	0.87	0.13	0.00	0.00	0.00	0.00
1995	938	0.92	0.07	0.01	0.00	0.00	0.00	901	0.86	0.14	0.01	0.00	0.00	0.00
1996	506	0.86	0.10	0.02	0.01	0.00	0.01	769	0.83	0.16	0.01	0.00	0.00	0.00
1997	523	0.87	0.10	0.02	0.01	0.00	0.00	682	0.82	0.17	0.01	0.00	0.00	0.00
1998	552	0.89	0.07	0.02	0.01	0.00	0.00	817	0.85	0.14	0.00	0.00	0.00	0.00
1999	748	0.88	0.10	0.02	0.00	0.00	0.00	981	0.80	0.19	0.01	0.00	0.00	0.00
2000	507	0.84	0.10	0.04	0.01	0.00	0.01	938	0.86	0.12	0.01	0.00	0.00	0.00
2001	319	0.82	0.13	0.03	0.01	0.00	0.01	610	0.75	0.23	0.01	0.00	0.00	0.00
2002	384	0.84	0.12	0.02	0.01	0.00	0.01	517	0.83	0.15	0.00	0.00	0.00	0.01
2003	454	0.93	0.05	0.02	0.00	0.00	0.00	519	0.88	0.11	0.01	0.00	0.00	0.01
2004	448	0.90	0.05	0.02	0.00	0.00	0.02	500	0.88	0.09	0.01	0.00	0.00	0.02
2005	726	0.93	0.06	0.00	0.00	0.00	0.00	731	0.89	0.09	0.00	0.00	0.00	0.01
2006	606	0.89	0.09	0.02	0.00	0.00	0.00	795	0.75	0.23	0.01	0.00	0.00	0.00
2007	571	0.91	0.06	0.01	0.01	0.00	0.01	666	0.85	0.13	0.01	0.00	0.00	0.00
2008	703	0.91	0.07	0.01	0.00	0.00	0.01	815	0.81	0.17	0.01	0.00	0.00	0.01
2009	583	0.90	0.06	0.01	0.01	0.00	0.01	733	0.83	0.16	0.01	0.00	0.00	0.00
2010	401	0.89	0.06	0.02	0.01	0.00	0.02	409	0.86	0.12	0.01	0.00	0.00	0.00
2011	535	0.87	0.10	0.01	0.01	0.00	0.00	550	0.80	0.19	0.01	0.00	0.00	0.00
2012	363	0.88	0.10	0.01	0.00	0.00	0.01	581	0.84	0.15	0.01	0.00	0.00	0.00
2013	817	0.73	0.11	0.05	0.06	0.03	0.03	667	0.80	0.17	0.02	0.00	0.00	0.01

	1.5" mesh						
Year	n	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6+
1986	277	0.36	0.61	0.03	0.00	0.00	0.00
1987	464	0.50	0.48	0.02	0.00	0.00	0.00
1988	726	0.75	0.23	0.01	0.00	0.00	0.00
1989	588	0.56	0.43	0.01	0.00	0.00	0.00
1990	405	0.53	0.46	0.01	0.00	0.00	0.00
1991	529	0.36	0.63	0.01	0.00	0.00	0.00
1992	704	0.46	0.53	0.01	0.00	0.00	0.00
1993	628	0.50	0.48	0.02	0.00	0.00	0.00
1994	434	0.53	0.45	0.02	0.00	0.00	0.00
1995	520	0.42	0.56	0.02	0.00	0.00	0.00
1996	495	0.43	0.54	0.03	0.00	0.00	0.00
1997	492	0.46	0.51	0.03	0.00	0.00	0.00
1998	438	0.53	0.44	0.03	0.00	0.00	0.00
1999	768	0.50	0.47	0.02	0.00	0.00	0.00
2000	683	0.55	0.40	0.04	0.01	0.00	0.00
2001	474	0.49	0.47	0.03	0.01	0.00	0.00
2002	260	0.52	0.46	0.01	0.00	0.00	0.01
2003	280	0.55	0.43	0.01	0.00	0.00	0.00
2004	316	0.59	0.36	0.02	0.00	0.00	0.02
2005	261	0.53	0.41	0.03	0.01	0.00	0.02
2006	496	0.39	0.57	0.04	0.00	0.00	0.00
2007	365	0.56	0.40	0.03	0.00	0.00	0.01
2008	334	0.48	0.47	0.03	0.01	0.00	0.01
2009	483	0.50	0.47	0.02	0.00	0.00	0.00
2010	184	0.38	0.54	0.06	0.01	0.01	0.01
2011	321	0.42	0.55	0.02	0.00	0.00	0.00
2012	267	0.29	0.66	0.04	0.00	0.00	0.00
2013	332	0.38	0.55	0.06	0.01	0.00	0.00

Table 10: Recreational spotted seatrout catch-at-age and yield (females only).

Recreational Catch-at-age							
Year	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6+	Yield (lbs)
1981	976,621	374,444	85,418	26,406	14,751	17,217	1,744,644
1982	3,707,516	803,717	255,948	53,977	25,261	94,313	5,964,071
1983	2,467,971	1,062,470	116,604	45,225	15,371	20,997	4,375,916
1984	584,276	347,452	77,995	54,719	27,766	46,105	1,982,751
1985	1,953,041	357,806	58,835	19,892	5,986	6,951	2,316,159
1986	4,692,513	1,383,315	140,078	30,745	10,271	19,849	6,025,966
1987	4,159,817	1,561,824	76,149	17,473	3,983	3,036	5,782,142
1988	2,269,082	1,628,079	222,607	59,076	16,824	21,084	5,257,797
1989	1,792,860	1,556,366	174,562	38,851	11,855	22,363	4,599,691
1990	1,267,991	575,057	62,476	8,745	2,187	3,147	2,226,892
1991	4,068,657	1,442,015	113,102	18,454	6,376	11,922	5,921,816
1992	3,420,904	1,379,016	102,113	18,469	5,773	9,623	5,267,701
1993	3,174,466	1,042,846	151,409	32,759	10,932	18,591	4,774,934
1994	3,374,149	1,331,213	158,694	45,126	16,716	27,493	5,550,275
1995	3,842,694	1,420,298	217,591	54,851	19,006	38,706	6,282,887
1996	3,170,899	1,711,911	210,402	39,084	14,520	20,587	6,267,978
1997	3,575,257	1,732,247	202,365	27,246	11,214	27,492	6,182,984
1998	2,461,855	1,494,603	184,013	33,187	8,329	6,035	4,747,741
1999	3,393,585	2,078,119	280,957	76,752	24,447	33,076	6,983,043
2000	4,383,702	3,079,002	504,372	110,411	33,137	47,085	10,405,566
2001	3,438,711	2,327,327	506,094	117,250	42,534	80,097	8,713,211
2002	2,507,528	1,339,659	481,859	74,823	23,296	41,476	5,617,866
2003	3,171,303	2,405,589	445,031	76,147	31,975	47,453	7,386,712
2004	3,535,964	3,021,709	422,424	61,586	21,599	43,669	7,873,026
2005	2,825,056	3,041,816	331,487	23,684	11,313	8,806	6,864,200
2006	3,897,550	4,666,873	574,616	41,068	7,937	12,646	10,769,517
2007	3,618,680	3,131,361	566,796	83,775	25,843	38,761	8,727,818
2008	4,281,382	4,464,189	965,533	62,344	13,717	22,729	11,098,578
2009	3,329,729	4,567,596	743,502	120,300	8,519	30,541	9,884,561
2010	3,782,692	2,130,171	462,965	71,496	8,792	21,442	7,365,025
2011	4,314,612	3,652,827	714,766	116,037	29,831	79,158	11,439,906
2012	3,950,247	3,362,258	651,941	85,949	32,307	51,197	10,334,100
2013	4,271,588	2,990,786	293,989	45,572	11,674	19,503	8,518,206

Table 11: Commercial spotted seatrout catch-at-age and yield (females only).

Commercial Catch-at-age							
Year	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6+	Yield (lbs)
1981	119,872	191,946	24,886	5,741	2,596	7,603	529,190
1982	148,620	237,981	30,855	7,118	3,218	9,427	656,106
1983	273,835	438,483	56,851	13,116	5,929	17,369	1,208,886
1984	198,796	318,325	41,272	9,522	4,305	12,610	877,612
1985	237,267	379,928	49,259	11,364	5,138	15,050	1,047,451
1986	480,199	718,538	62,403	13,574	6,083	17,817	1,810,085
1987	198,680	670,563	114,420	15,342	4,082	6,131	1,671,991
1988	158,052	533,440	91,022	12,205	3,247	4,877	1,330,085
1989	164,168	554,083	94,544	12,677	3,373	5,066	1,381,556
1990	71,522	241,392	41,189	5,523	1,469	2,207	601,889
1991	134,546	454,106	77,485	10,390	2,764	4,152	1,132,274
1992	107,118	361,534	61,689	8,272	2,201	3,306	901,454
1993	125,487	423,530	72,268	9,690	2,578	3,872	1,056,035
1994	112,875	380,963	65,004	8,716	2,319	3,483	949,897
1995	72,562	244,904	41,789	5,603	1,491	2,239	610,648
1996	85,396	288,219	49,179	6,594	1,754	2,635	718,648
1997	21,243	256,398	36,804	4,392	1,898	4,286	502,434
1998	4,468	52,902	8,234	1,406	347	213	101,930
1999	2,200	32,227	5,462	1,681	521	551	70,447
2000	4,578	14,040	2,716	579	166	215	37,358
2001	3,023	37,436	11,741	2,362	790	1,389	102,486
2002	3,629	21,529	9,947	1,543	574	849	66,732
2003	119	7,394	2,227	474	143	188	18,002
2004	0	8,580	1,893	259	131	212	18,392
2005	142	8,826	1,301	89	58	46	15,370
2006	13	1,019	176	10	2	4	1,867
2007	0	4,258	1,411	193	57	71	10,288
2008	22	4,679	1,954	123	28	46	10,638
2009	4	465	124	16	2	4	906
2010	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0
2012	1	40	10	1	0	1	91
2013	1,320	820	85	24	6	16	3,363

Table 12: Mean weight-at-age (pounds) of recreational and commercial spotted seatrout landings (females only).

Recreational Mean Weight-at-age						
Year	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6+
1981	0.76	1.54	2.41	3.52	3.89	3.96
1982	0.84	1.74	2.62	3.36	4.05	5.29
1983	0.88	1.50	2.66	3.30	3.79	4.19
1984	0.90	2.02	3.12	3.79	4.00	4.19
1985	0.78	1.46	2.54	3.32	3.54	4.54
1986	0.72	1.48	2.55	3.32	3.83	4.69
1987	0.82	1.34	2.61	3.16	3.45	3.78
1988	0.89	1.41	2.65	3.30	3.67	4.24
1989	0.94	1.40	2.57	3.25	3.77	4.87
1990	0.88	1.56	2.58	3.15	3.74	4.22
1991	0.84	1.45	2.45	3.29	3.83	4.69
1992	0.85	1.42	2.62	3.28	3.80	4.42
1993	0.84	1.43	2.58	3.32	3.79	4.56
1994	0.84	1.45	2.71	3.41	3.84	4.47
1995	0.84	1.43	2.65	3.36	3.85	4.73
1996	0.88	1.55	2.58	3.42	3.85	4.15
1997	0.82	1.43	2.51	3.27	4.05	4.64
1998	0.83	1.40	2.52	3.24	3.47	3.66
1999	0.82	1.42	2.66	3.30	3.70	4.39
2000	0.86	1.50	2.64	3.28	3.73	4.35
2001	0.88	1.49	2.57	3.35	3.85	4.56
2002	0.91	1.34	2.14	2.96	3.85	4.55
2003	0.82	1.34	2.25	2.91	3.15	4.97
2004	0.83	1.20	2.11	2.77	3.83	4.13
2005	0.81	1.23	2.12	2.80	3.10	3.92
2006	0.80	1.34	2.04	3.00	3.85	4.29
2007	0.82	1.29	2.11	3.00	3.82	4.39
2008	0.86	1.19	1.86	2.68	3.76	4.62
2009	0.83	1.17	1.83	1.91	4.17	4.97
2010	0.86	1.31	2.13	2.55	3.97	4.85
2011	0.94	1.38	2.07	3.03	4.03	4.86
2012	0.87	1.45	2.18	2.87	3.29	4.79
2013	0.87	1.29	2.30	2.99	3.83	4.45

Commercial Mean Weight-at-age						
Year	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6+
1981	1.05	1.42	2.57	3.38	4.07	4.87
1982	1.05	1.42	2.57	3.38	4.07	4.87
1983	1.05	1.42	2.57	3.38	4.07	4.87
1984	1.05	1.42	2.57	3.38	4.07	4.87
1985	1.05	1.42	2.57	3.38	4.07	4.87
1986	1.05	1.38	2.54	3.37	4.07	4.87
1987	1.19	1.59	2.45	3.15	3.68	4.53
1988	1.19	1.59	2.45	3.15	3.68	4.53
1989	1.19	1.59	2.45	3.15	3.68	4.53
1990	1.19	1.59	2.45	3.15	3.68	4.53
1991	1.19	1.59	2.45	3.15	3.68	4.53
1992	1.19	1.59	2.45	3.15	3.68	4.53
1993	1.19	1.59	2.45	3.15	3.68	4.53
1994	1.19	1.59	2.45	3.15	3.68	4.53
1995	1.19	1.59	2.45	3.15	3.68	4.53
1996	1.19	1.59	2.45	3.15	3.68	4.53
1997	1.16	1.36	2.36	3.22	4.02	4.58
1998	1.17	1.33	2.40	3.20	3.44	3.57
1999	1.17	1.37	2.58	3.27	3.63	4.17
2000	1.19	1.53	2.59	3.23	3.69	4.28
2001	1.19	1.42	2.45	3.25	3.76	4.60
2002	1.27	1.37	2.19	3.29	3.81	4.30
2003	1.08	1.40	2.19	2.68	3.35	4.74
2004	3.48	1.39	2.22	3.34	3.79	4.40
2005	1.08	1.35	2.11	2.62	3.07	3.98
2006	1.22	1.39	2.13	3.03	3.90	4.31
2007	3.48	1.45	2.16	2.90	3.72	4.42
2008	1.08	1.30	1.97	2.91	3.77	4.57
2009	1.21	1.29	1.92	2.31	3.91	4.58
2010	1.08	1.38	2.33	2.69	3.98	4.95
2011	1.11	1.39	1.98	2.94	3.61	4.66
2012	1.14	1.48	2.42	2.70	3.79	4.37
2013	1.26	1.59	2.66	2.83	4.13	4.59

Table 13: Summary of objective function components and negative log-likelihood values of the ASAP base model.

Objective function=	21730		
Component	**Lambda**	**ESS**	**negLL**
Catch_Recreational	1	--	-17
Catch_Commercial	1	--	-53
Index_1.0" mesh	1	--	-29
Index_1.25" mesh	1	--	-24
Index_1.5" mesh	1	--	-18
Catch_agecomps	--	13200	12021
Index_agecomps	--	16400	9859
Selectivity_parms_catch	20	--	-5
Selectivity_parms_indices	12	--	16
Recruitment_devs	1	--	-20

Table 14: Annual female spotted seatrout abundance-at-age and stock size estimates from the ASAP base model.

Year	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6+	Totals
1981	5,658,250	1,577,040	410,513	243,800	293,277	2,006,810	10,189,690
1982	9,362,860	2,404,620	632,822	214,723	156,903	1,738,240	14,510,168
1983	6,477,630	2,398,140	485,247	209,491	110,014	1,376,070	11,056,592
1984	4,041,930	1,520,720	352,379	134,135	99,161	1,066,170	7,214,495
1985	8,007,730	1,488,580	401,851	144,495	77,384	866,385	10,986,425
1986	11,298,800	3,129,610	448,887	178,490	86,510	706,411	15,848,708
1987	10,891,400	3,202,000	575,849	144,806	91,397	575,066	15,480,518
1988	13,255,000	3,056,050	602,535	187,510	74,353	481,995	17,657,443
1989	9,655,770	4,777,320	499,675	180,826	98,906	410,564	15,623,061
1990	9,195,400	2,408,750	302,434	88,784	77,468	361,153	12,433,989
1991	11,503,800	3,742,300	592,510	118,308	52,145	327,927	16,336,990
1992	11,489,100	3,903,460	557,216	173,251	61,856	279,948	16,464,831
1993	12,215,400	3,796,420	572,966	165,317	91,225	250,924	17,092,252
1994	12,281,200	4,032,970	536,392	163,981	85,739	248,428	17,348,710
1995	11,764,500	3,882,150	524,973	148,566	84,008	242,321	16,646,518
1996	10,788,700	3,917,920	618,565	167,207	80,582	239,011	15,811,985
1997	9,798,980	3,647,620	636,440	197,516	90,741	234,227	14,605,524
1998	11,216,400	3,446,760	662,002	218,187	109,965	238,137	15,891,451
1999	12,121,200	4,314,540	861,661	279,713	132,569	259,067	17,968,750
2000	13,546,800	4,515,750	1,007,020	352,351	167,857	290,360	19,880,138
2001	8,801,880	4,594,640	840,399	365,610	201,805	335,857	15,140,191
2002	8,377,240	2,742,980	683,616	269,207	199,158	389,630	12,661,831
2003	9,176,110	3,007,890	581,227	264,910	158,117	434,626	13,622,880
2004	9,870,060	2,944,720	488,420	196,211	147,431	435,614	14,082,456
2005	11,595,900	3,165,070	477,428	164,764	109,169	428,977	15,941,308
2006	10,136,800	4,626,100	883,208	215,570	102,868	405,481	16,370,027
2007	11,844,600	3,674,690	1,021,510	352,232	128,169	379,901	17,401,102
2008	12,194,000	4,709,740	1,019,400	460,186	219,739	381,658	18,984,723
2009	9,647,450	4,154,630	890,138	373,771	264,649	441,239	15,771,877
2010	10,298,200	3,143,730	704,246	308,079	210,126	515,089	15,179,470
2011	10,063,600	3,683,360	671,623	275,964	181,906	537,941	15,414,394
2012	7,931,380	3,590,960	782,320	262,357	162,742	535,267	13,265,026
2013	10,818,200	2,417,580	515,812	247,773	142,411	512,242	14,654,018

Table 15: Annual female spotted seatrout age-specific, apical, and average fishing mortality rates estimated from the ASAP base model.

Year	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6+	Apical F	Avg. F
1981	0.30	0.54	0.34	0.16	0.07	0.03	0.54	0.35
1982	0.81	1.23	0.80	0.39	0.16	0.06	1.23	0.88
1983	0.89	1.55	0.98	0.47	0.20	0.08	1.55	1.05
1984	0.44	0.96	0.58	0.27	0.11	0.04	0.96	0.58
1985	0.38	0.83	0.50	0.23	0.10	0.04	0.83	0.45
1986	0.71	1.32	0.82	0.39	0.16	0.06	1.32	0.83
1987	0.72	1.30	0.82	0.39	0.16	0.06	1.30	0.84
1988	0.47	1.44	0.90	0.36	0.13	0.04	1.44	0.65
1989	0.83	2.39	1.42	0.57	0.20	0.07	2.39	1.34
1990	0.34	1.03	0.63	0.25	0.09	0.03	1.03	0.49
1991	0.53	1.54	0.92	0.37	0.13	0.05	1.54	0.78
1992	0.55	1.55	0.91	0.36	0.13	0.04	1.55	0.80
1993	0.55	1.59	0.94	0.38	0.14	0.05	1.59	0.80
1994	0.60	1.67	0.98	0.39	0.14	0.05	1.67	0.86
1995	0.54	1.47	0.84	0.33	0.12	0.04	1.47	0.77
1996	0.53	1.45	0.83	0.33	0.12	0.04	1.45	0.77
1997	0.49	1.34	0.76	0.31	0.11	0.04	1.34	0.72
1998	0.40	1.02	0.55	0.22	0.08	0.03	1.02	0.54
1999	0.43	1.09	0.59	0.23	0.08	0.03	1.09	0.60
2000	0.53	1.31	0.71	0.28	0.10	0.03	1.31	0.71
2001	0.61	1.54	0.83	0.33	0.12	0.04	1.54	0.91
2002	0.47	1.18	0.64	0.25	0.09	0.03	1.18	0.64
2003	0.58	1.45	0.78	0.31	0.11	0.04	1.45	0.79
2004	0.58	1.45	0.78	0.31	0.11	0.04	1.45	0.77
2005	0.36	0.91	0.49	0.19	0.07	0.02	0.91	0.48
2006	0.46	1.14	0.61	0.24	0.09	0.03	1.14	0.66
2007	0.37	0.91	0.49	0.19	0.07	0.02	0.91	0.49
2008	0.52	1.30	0.70	0.28	0.10	0.03	1.30	0.72
2009	0.57	1.41	0.75	0.30	0.11	0.04	1.41	0.80
2010	0.47	1.17	0.63	0.25	0.09	0.03	1.17	0.63
2011	0.48	1.18	0.63	0.25	0.09	0.03	1.18	0.66
2012	0.63	1.57	0.84	0.33	0.12	0.04	1.57	0.91
2013	0.51	1.27	0.68	0.27	0.10	0.03	1.27	0.64

Table 16: Limit and target reference point estimates for the Louisiana spotted seatrout stock. Spawning stock biomass units are pounds x 10^6. Fishing mortality units are $year^{-1}$.

Management Benchmarks		
Parameters	Derivation	Value
SPR_{limit}	Equation [29] and SSB_{limit}	8.1%
SSB_{limit}	Lowest SSB (1990)	5.6
F_{limit}	Equation [29] and SPR_{limit}	0.79
SPR_{target}	Equation [29] and SSB_{target}	10.9%
SSB_{target}	Median SSB	7.5
F_{target}	Equation [29] and SPR_{target}	0.67

Table 17: Sensitivity analysis table of proposed limit reference points. Current estimates are taken as the geometric mean of 2011-2013 estimates. Yield and spawning stock biomass units are millions of pounds, and fishing mortality units are years^{-1}.

Model run	negLL	SPR_{limit}	$Yield_{limit}$	F_{limit}	SSB_{limit}	$SPR_{current}$	$F_{current}/F_{limit}$	$SSB_{current}/SSB_{limit}$
Base Model (h=1)	21730	8.1%	6.7	0.79	5.6	10.0%	0.92	1.38
Model 1 (h=0.95)	21754	8.8%	6.5	0.76	5.8	10.2%	0.96	1.34
Model 2 (h=0.90)	21745	8.8%	6.2	0.75	5.6	10.0%	0.96	1.37
Model 3 (h=0.85)	21732	9.0%	5.8	0.75	5.4	10.1%	0.97	1.45
Model 4 (h=0.80)	21733	9.3%	5.6	0.73	5.3	10.1%	0.99	1.47
Model 5 (1983,1989 winterkills)	21726	7.7%	6.9	0.81	5.4	10.1%	0.90	1.44
Model 6 (Catch lambdas*10)	20844	6.5%	7.0	0.88	4.6	7.6%	0.96	2.04
Model 7 (IOA lambdas*10)	20915	7.9%	6.8	0.79	5.4	12.4%	0.79	1.20

Table 18: Sensitivity analysis table of MSY related reference points. Current estimates are taken as the geometric mean of 2011-2013 estimates. Yield and spawning stock biomass units are millions of pounds, and fishing mortality units are years^{-1}.

Model run	negLL	SPR_{MSY}	MSY	F_{MSY}	SSB_{MSY}	$SPR_{current}$	$F_{current}/F_{MSY}$	$SSB_{current}/SSB_{MSY}$
Base Model (h=1)	21730	--	--	--	--	10.0%	--	--
Model 1 (h=0.95)	21754	12.5%	6.6	0.62	8.7	10.2%	1.16	0.90
Model 2 (h=0.90)	21745	17.8%	7.0	0.49	13.8	10.0%	1.48	0.55
Model 3 (h=0.85)	21732	22.1%	8.0	0.42	20.7	10.1%	1.73	0.38
Model 4 (h=0.81)	21733	25.3%	9.7	0.37	29.8	10.1%	1.94	0.26
Model 5 (1983,1989 winterkills)	21726	--	--	--	--	10.1%	--	--
Model 6 (Catch lambdas*10)	20844	--	--	--	--	7.6%	--	--
Model 7 (IOA lambdas*10)	20915	--	--	--	--	12.4%	--	--

11. Figures

Figure 1: Reported commercial spotted seatrout landings (pounds x 10^6) of the Gulf of Mexico derived from NMFS statistical records and the LDWF trip ticket program.

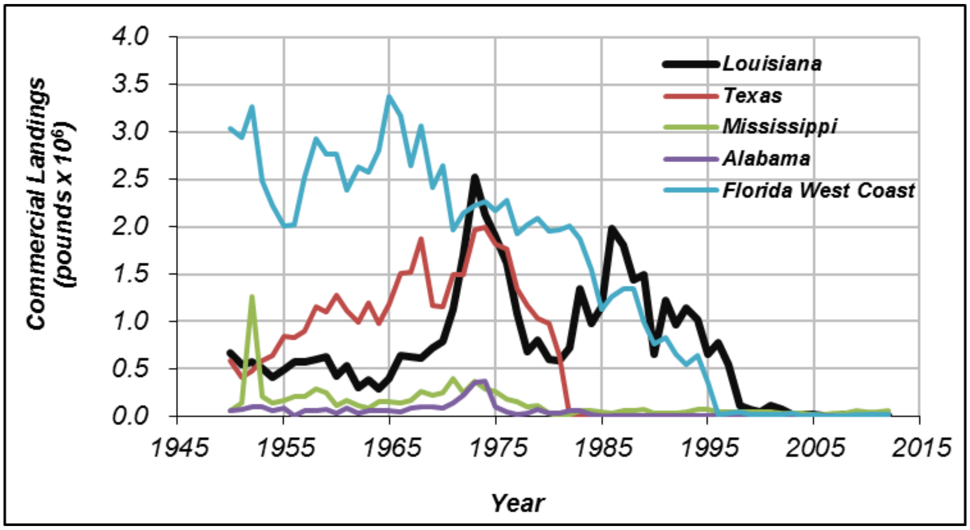

Figure 2: Estimated recreational spotted seatrout landings (pounds x 10^6) of the Gulf of Mexico derived from MRFSS/MRIP. Note: Texas does not participate in the MRFSS/MRIP survey.

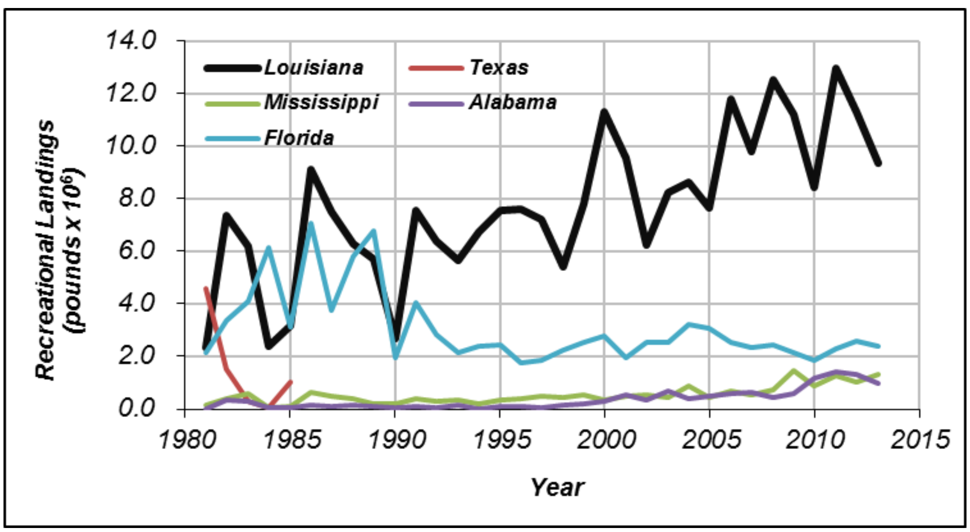

Figure 3: Standardized indices of abundance, nominal catch-per-unit-effort, and 95% confidence intervals of the standardized indices derived from the LDWF experimental marine gillnet survey. Each time-series has been normalized to its individual long-term mean for comparison.

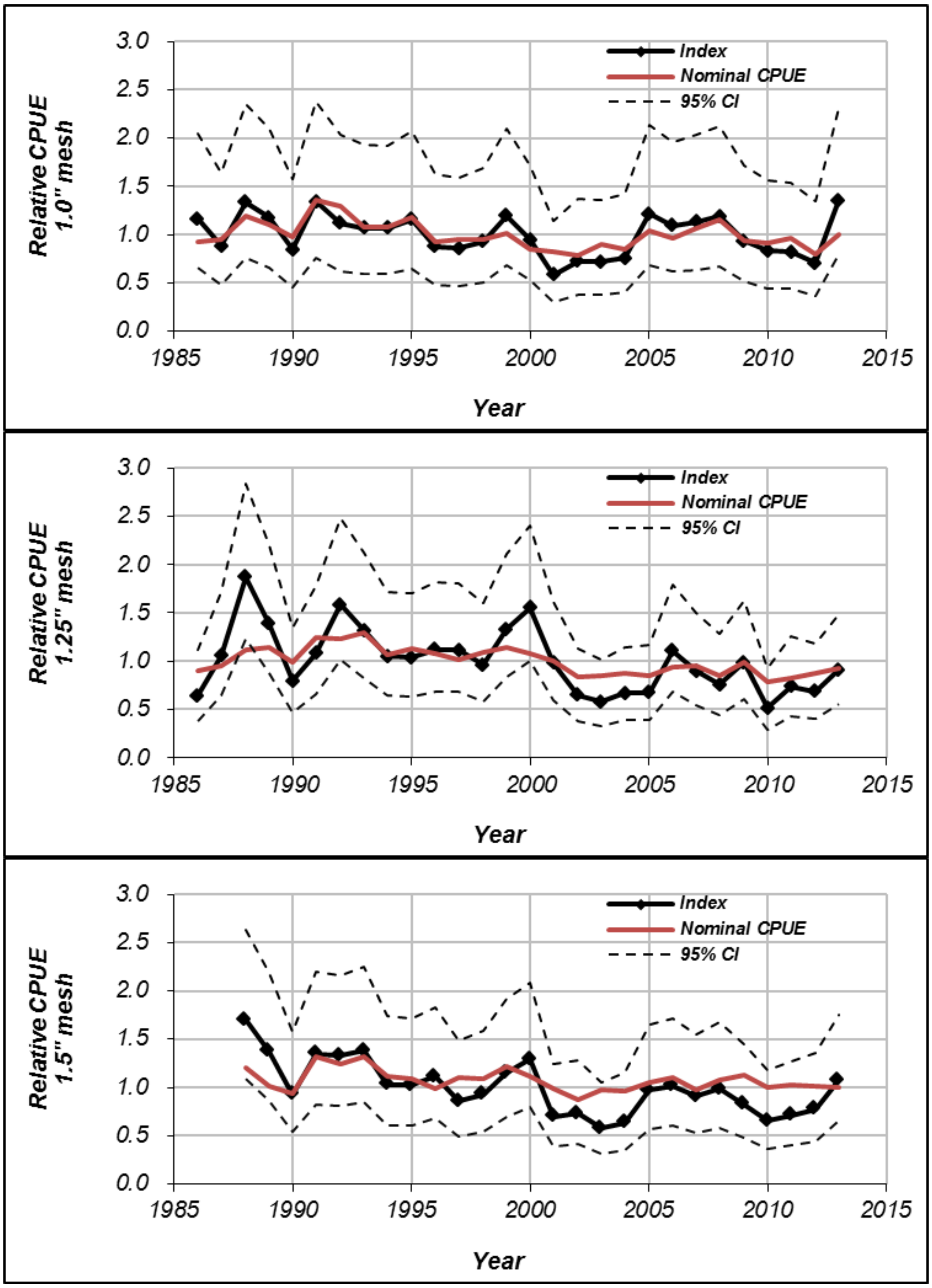

Figure 4: Observed and ASAP base model estimated commercial yield (females only; top) and standardized residuals (bottom).

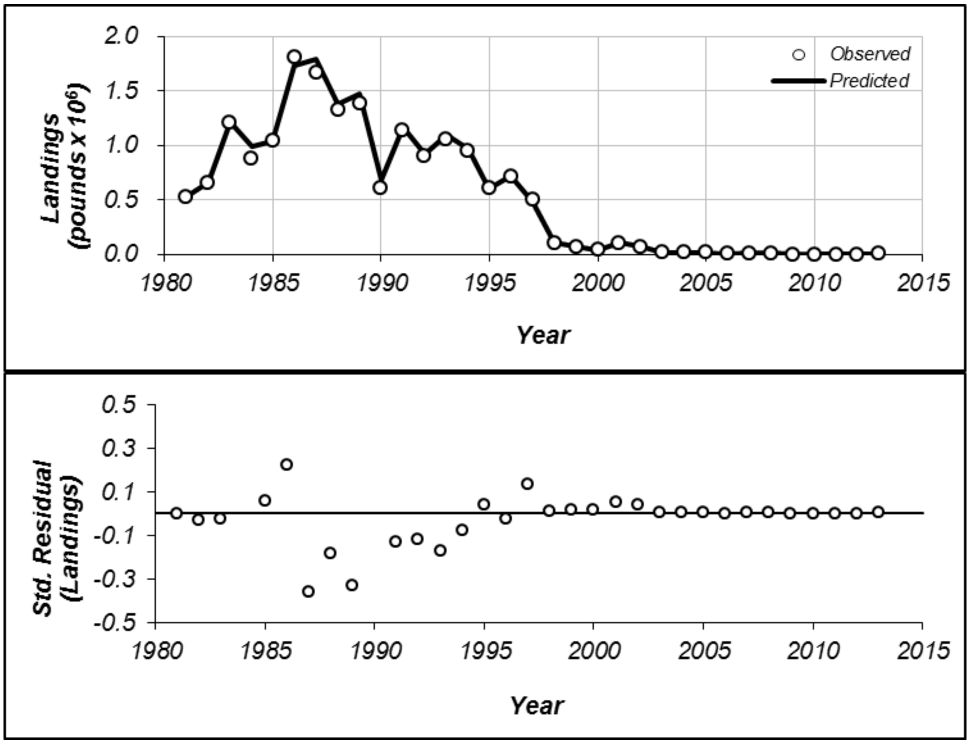

Figure 5: Observed and ASAP base model estimated recreational yield (females only; top) and standardized residuals (bottom).

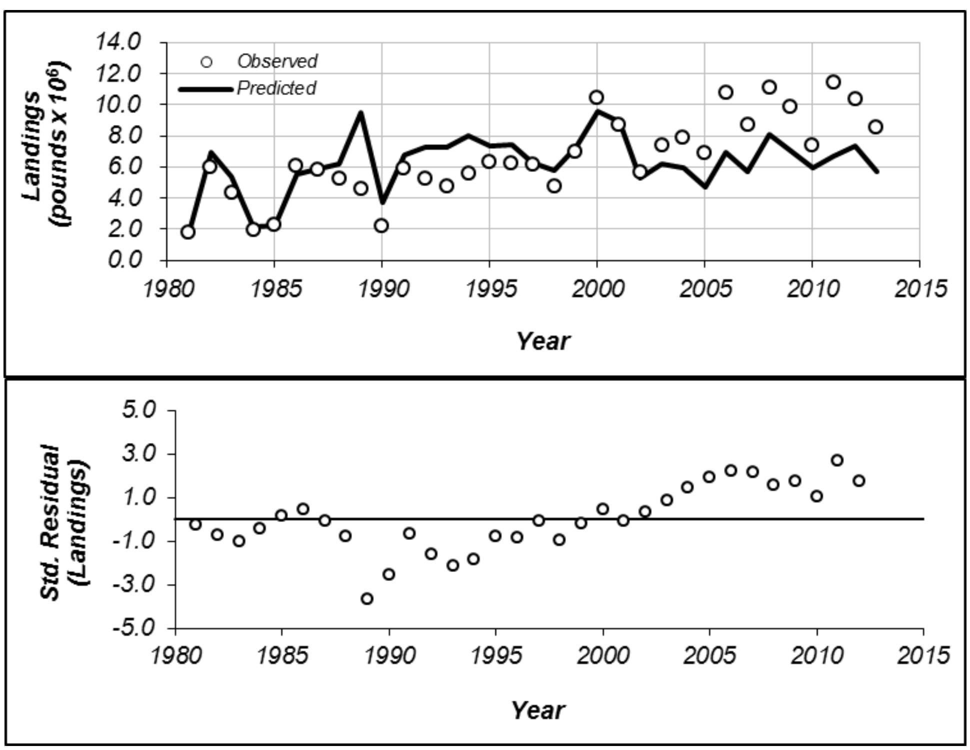

Figure 6: Observed and ASAP base model estimated survey CPUE (1.0" mesh; females only, top) and standardized residuals (bottom).

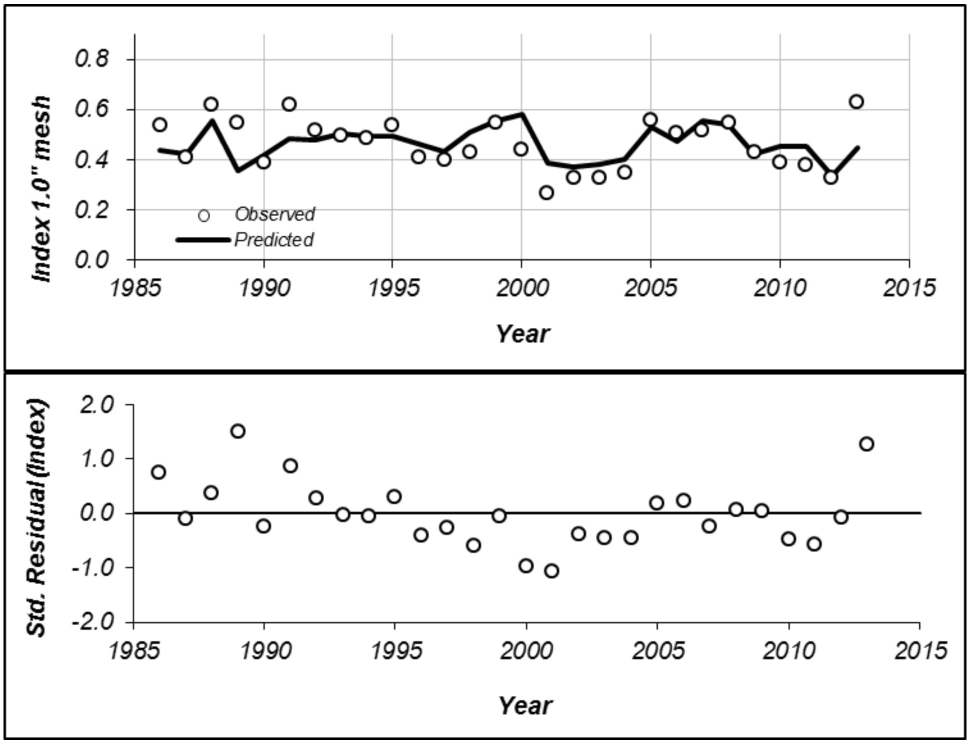

Figure 7: Observed and ASAP base model estimated survey CPUE (1.25" mesh; females only, top) and standardized residuals (bottom).

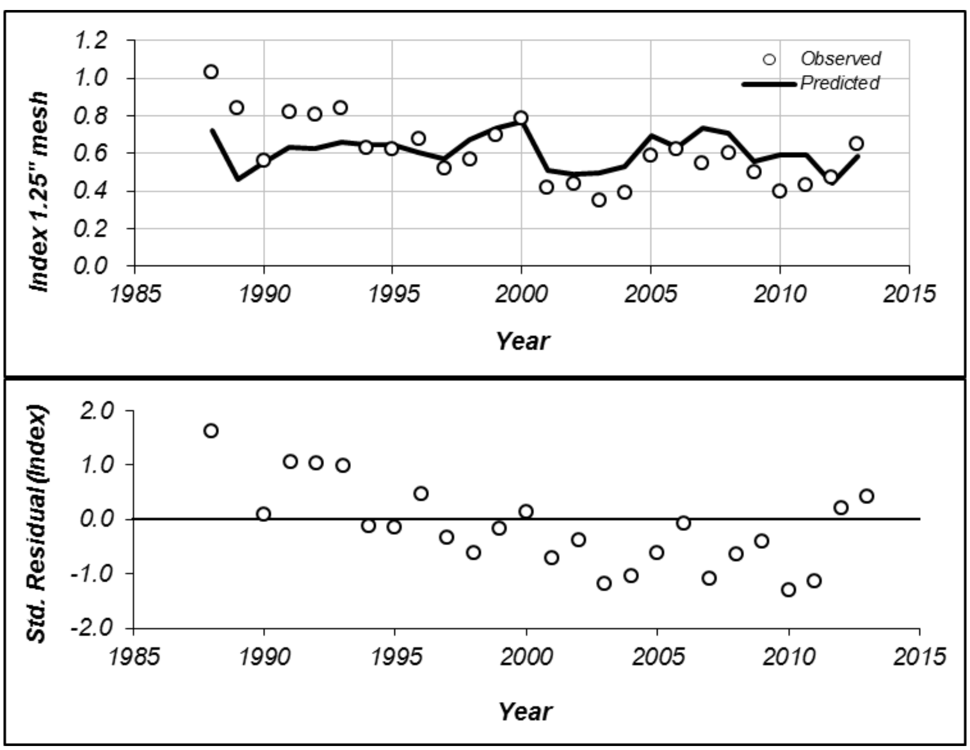

Figure 8: Observed and ASAP base model estimated survey CPUE (1.5" mesh; females only, top) and standardized residuals (bottom).

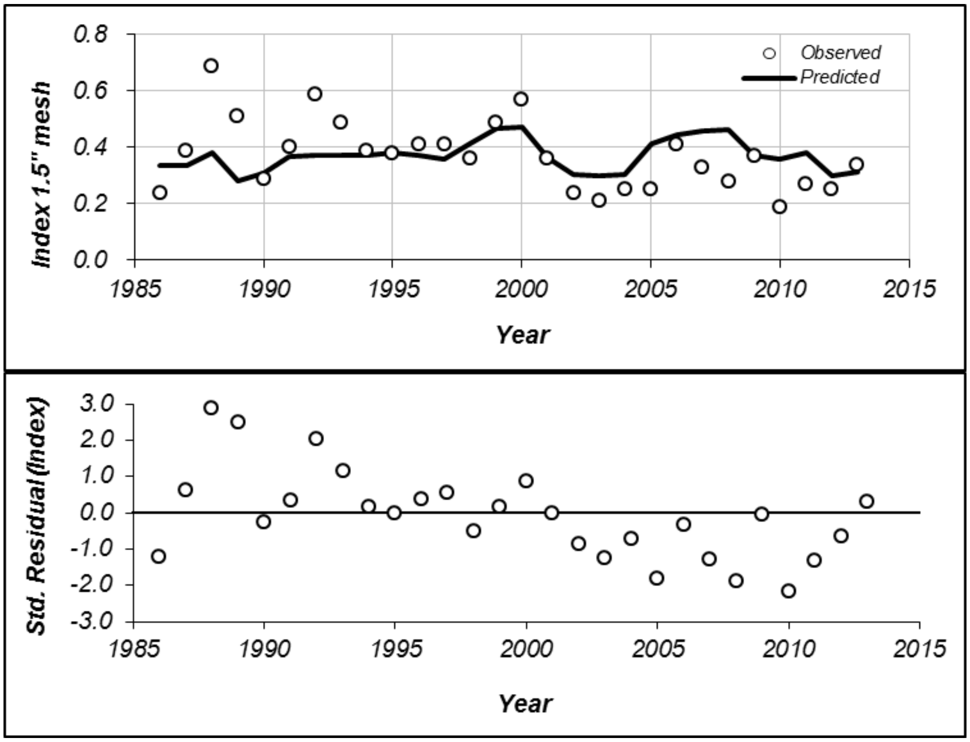

Figure 9: Overall (average) input (open circles) and ASAP estimated (bold lines) age compositions of survey catches.

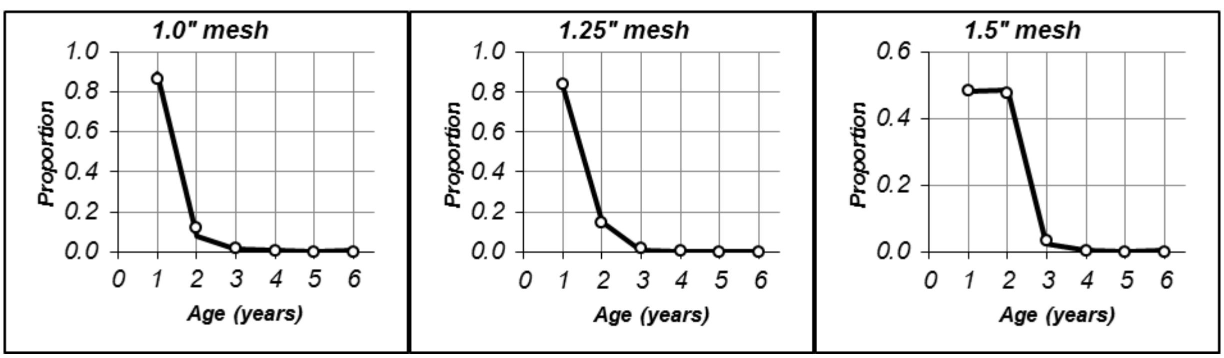

Figure 10: Annual input (open circles) and ASAP estimated (bold lines) commercial harvest age compositions.

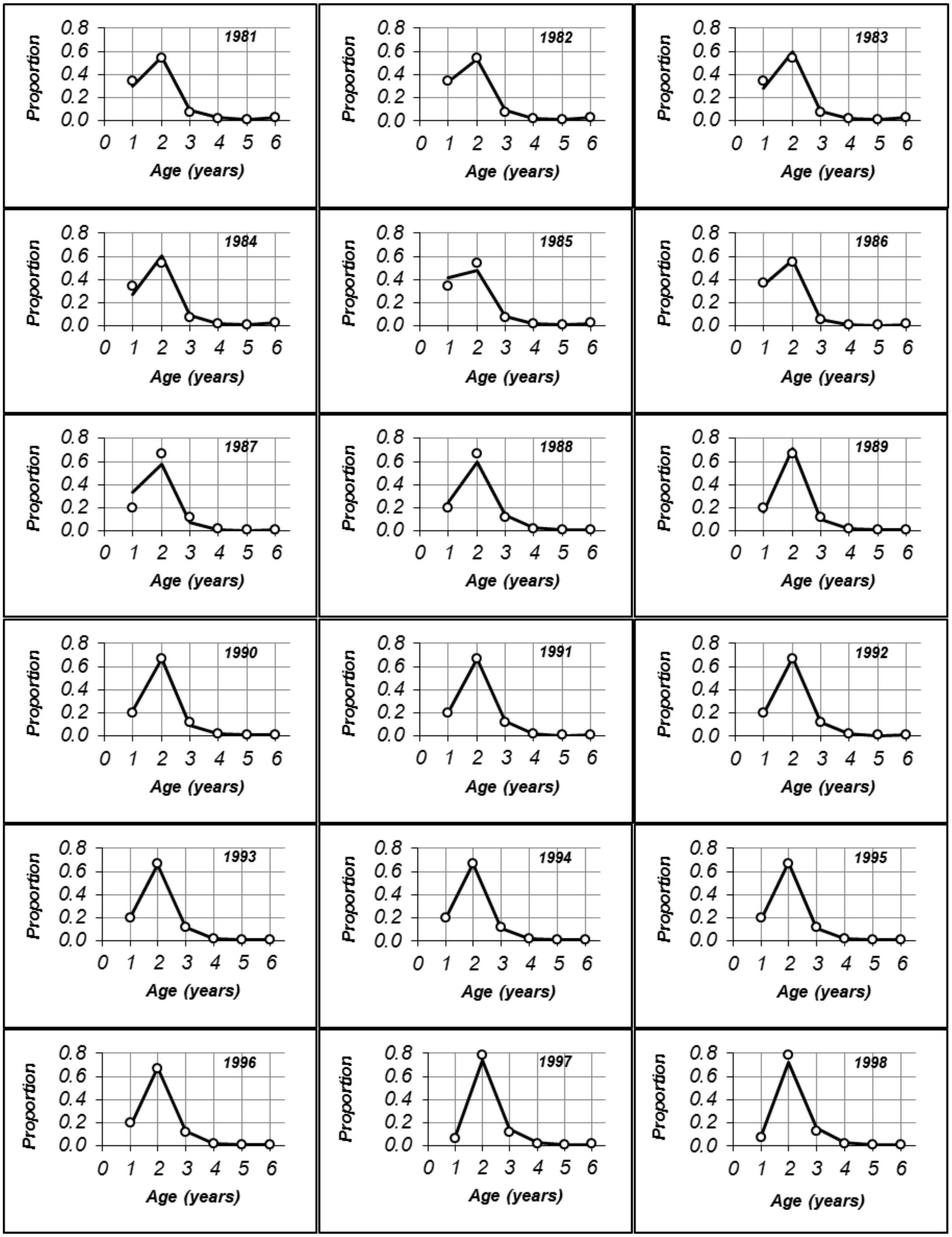

Figure 10 (continued):

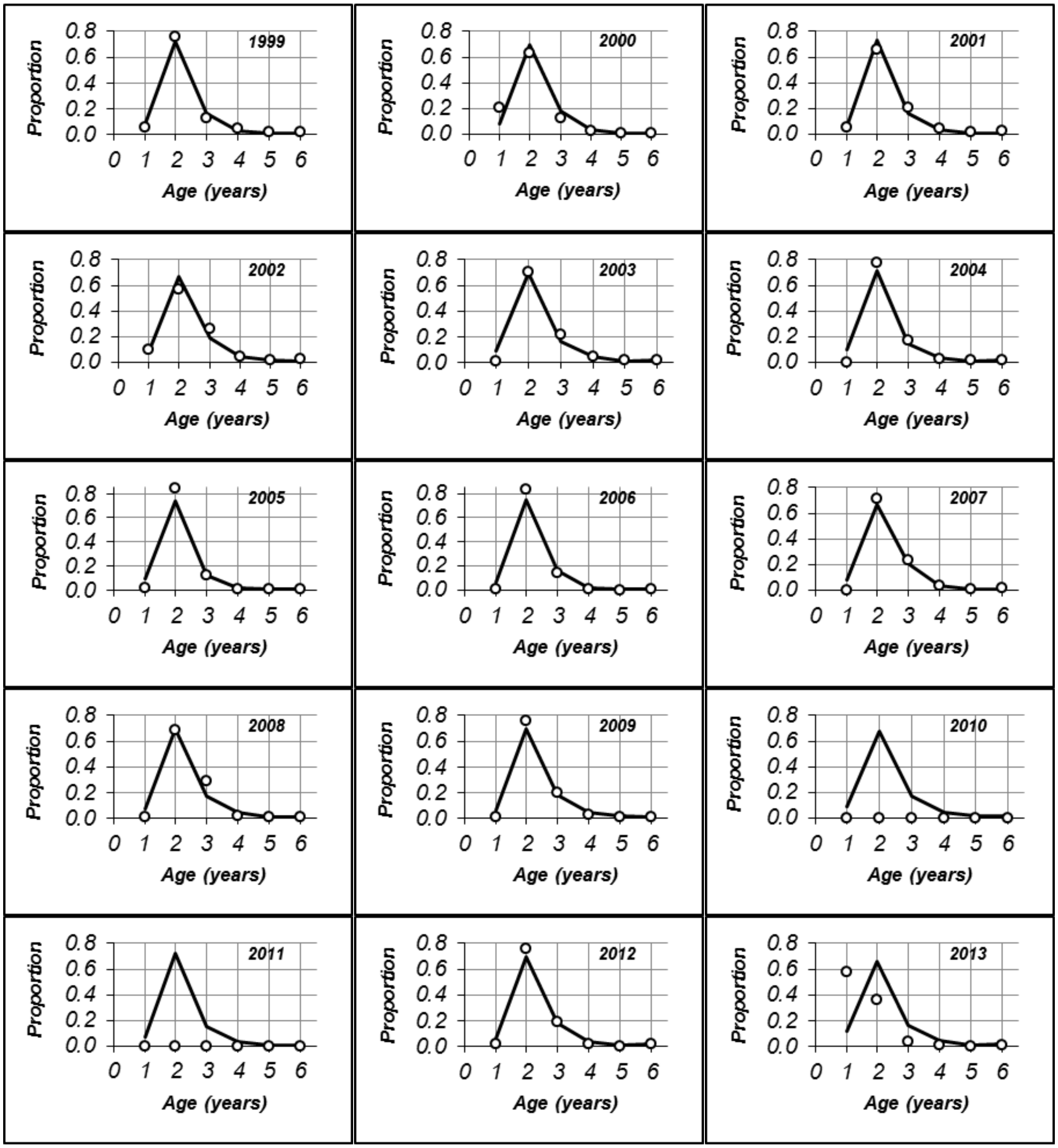

Figure 11: Annual input (open circles) and ASAP estimated (bold lines) recreational harvest age compositions.

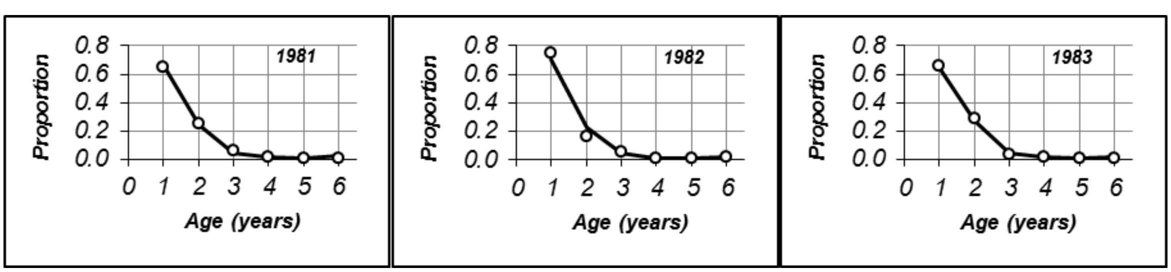

Figure 11 (continued):

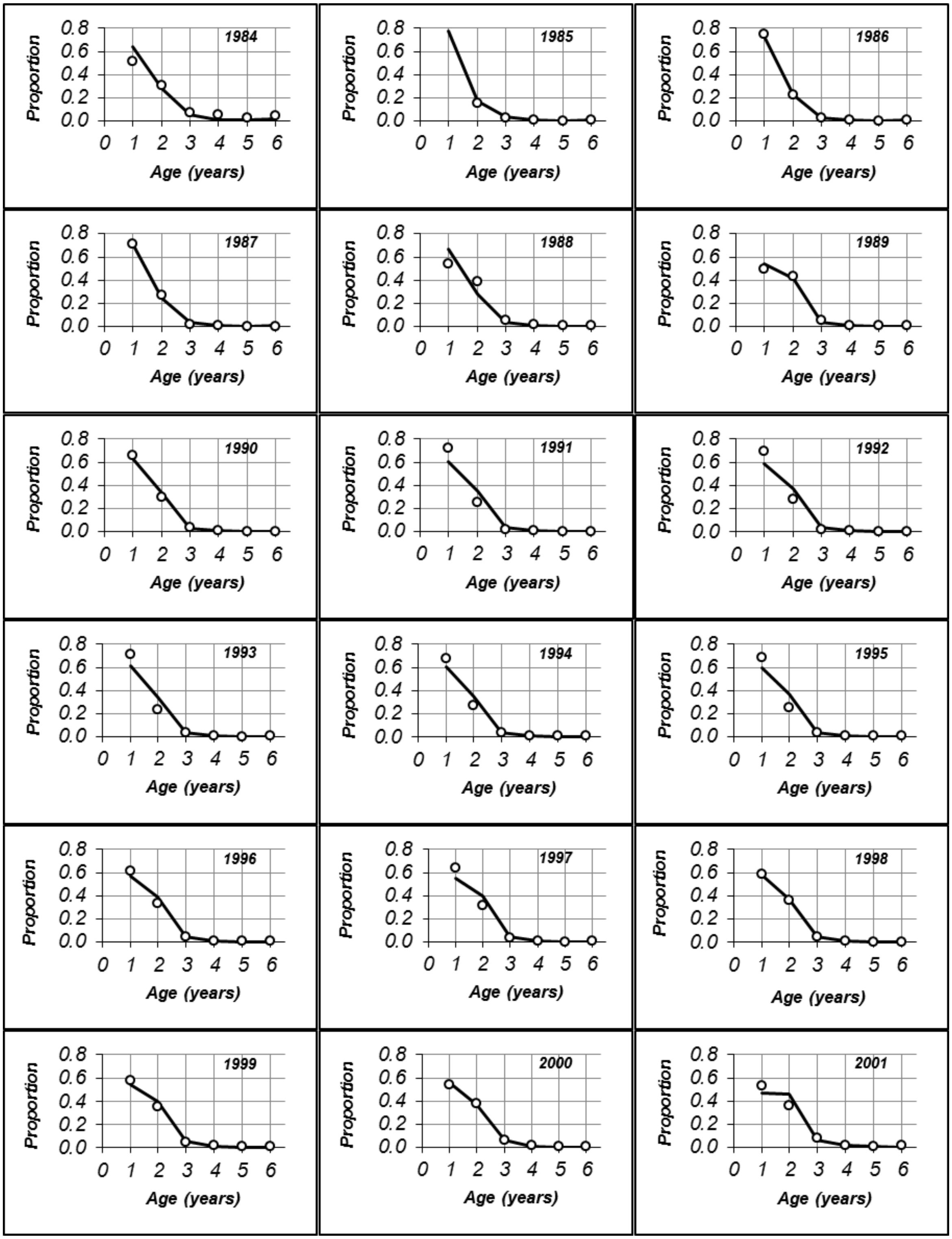

Figure 11 (continued):

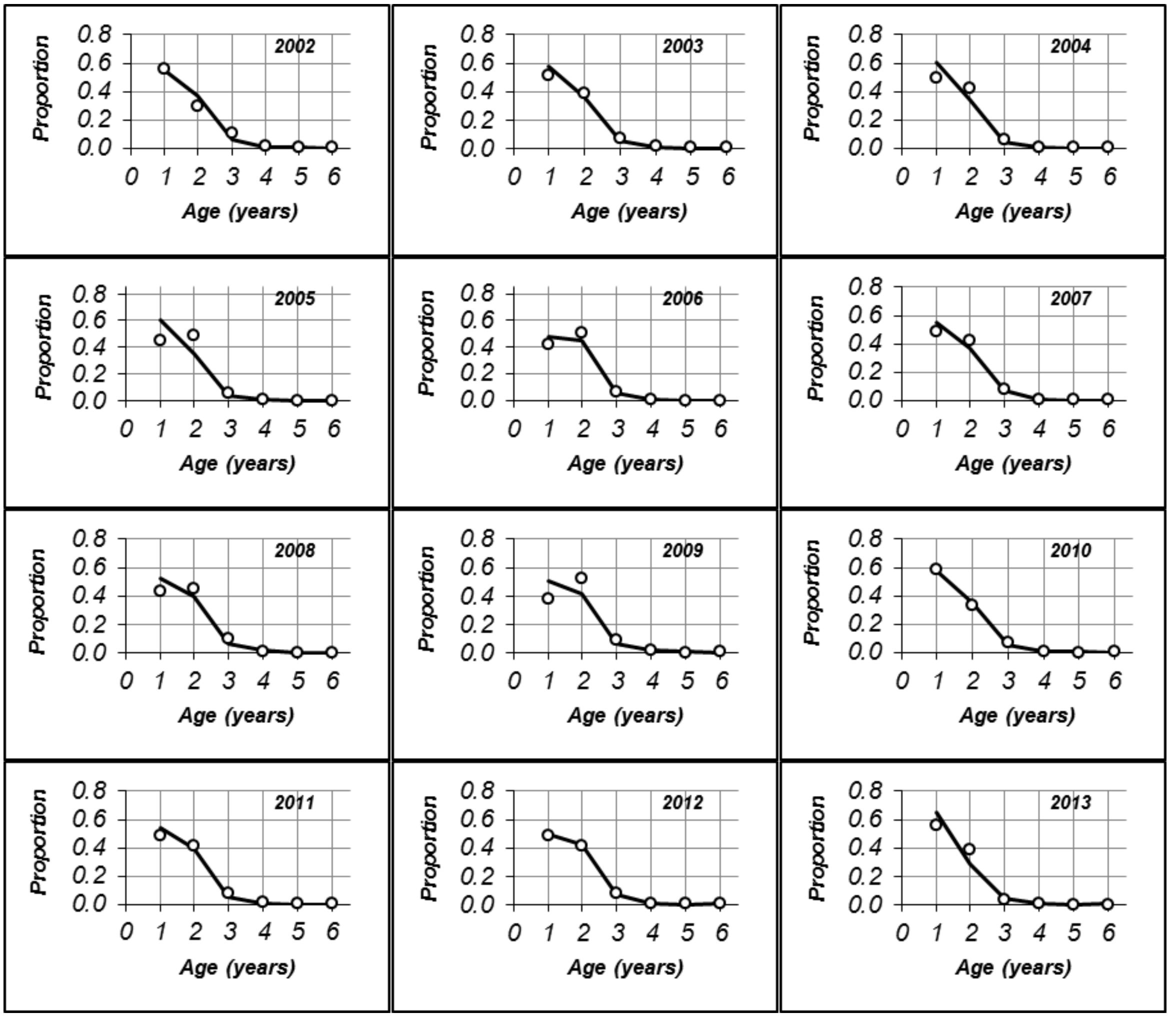

Figure 12: ASAP base model estimated survey selectivities (females only).

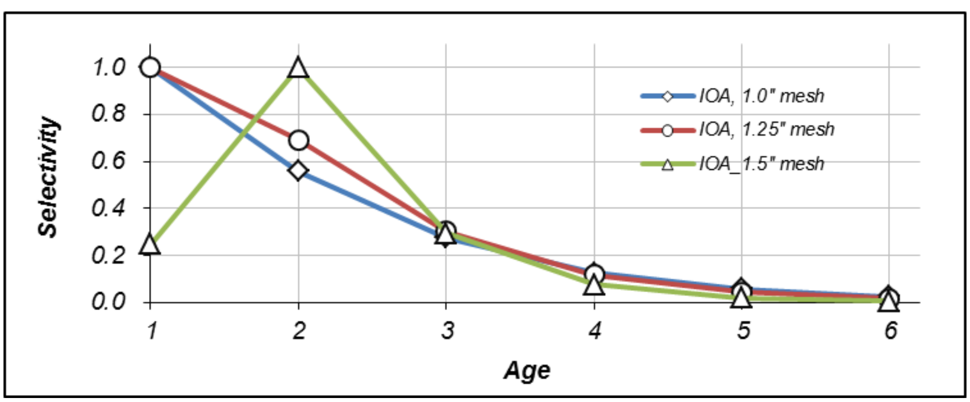

Figure 13: ASAP base model estimated fishery selectivities (females only).

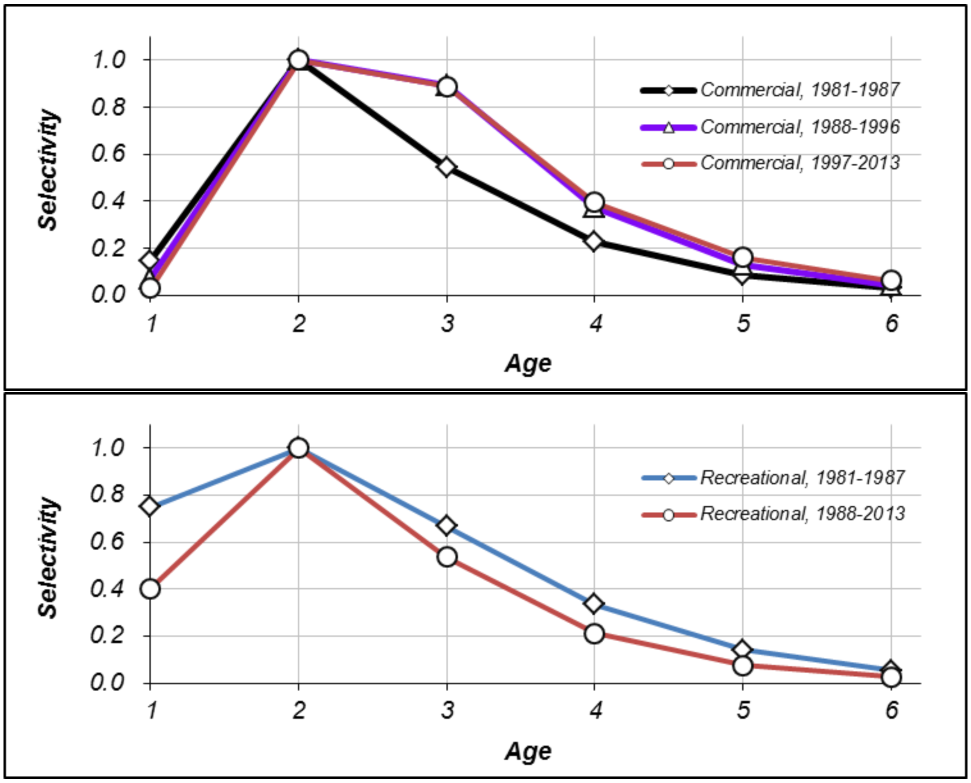

Figure 14: ASAP base model estimated recruitment (age-1 females). Dashed lines represent ±1 asymptotic standard errors.

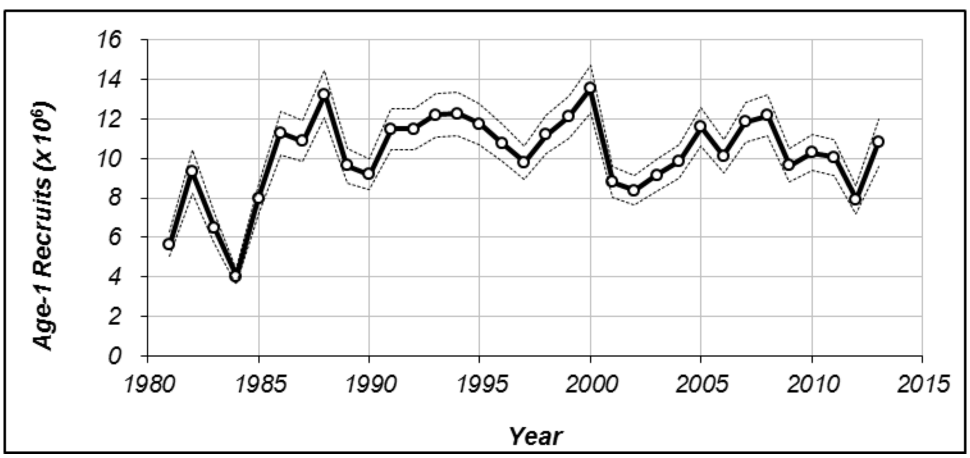

Figure 15: ASAP base model estimated female spawning stock biomass (MCMC median). Dashed lines represent 95% MCMC derived confidence intervals.

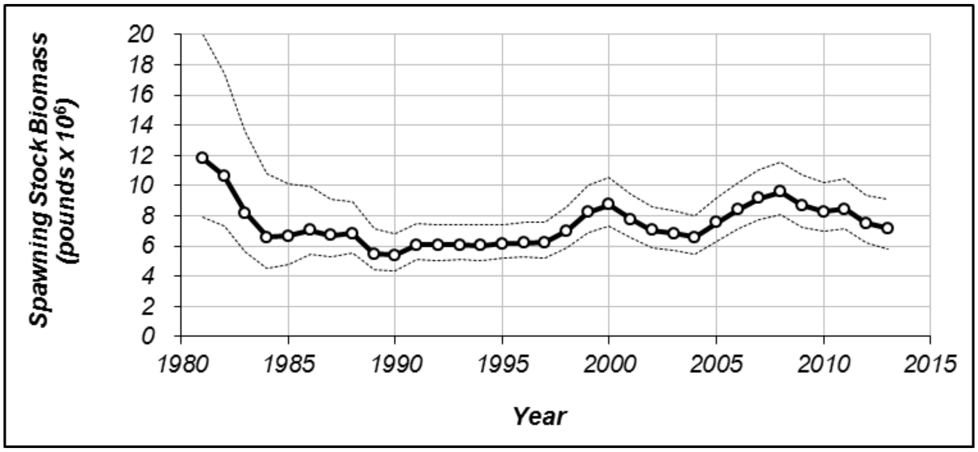

Figure 16: ASAP base model estimated average fishing mortality (MCMC median). Dashed lines represent 95% MCMC derived confidence intervals.

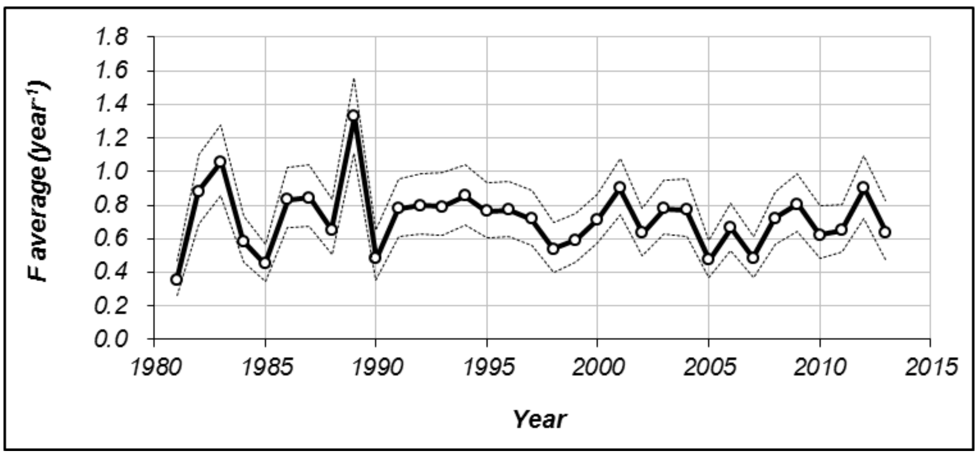

Figure 17: ASAP base model estimated age-1 recruits and female spawning stock biomass. Arrows represent direction of the time-series. The yellow circle represents the most current data pair.

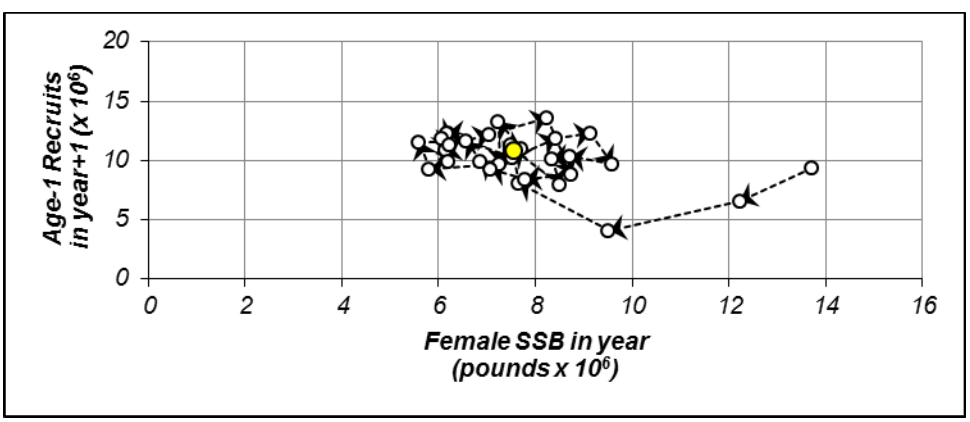

Figure 18: Time-series of ASAP base model estimated average fishing mortality rates and female spawning stock biomass relative to proposed limit and target reference points.

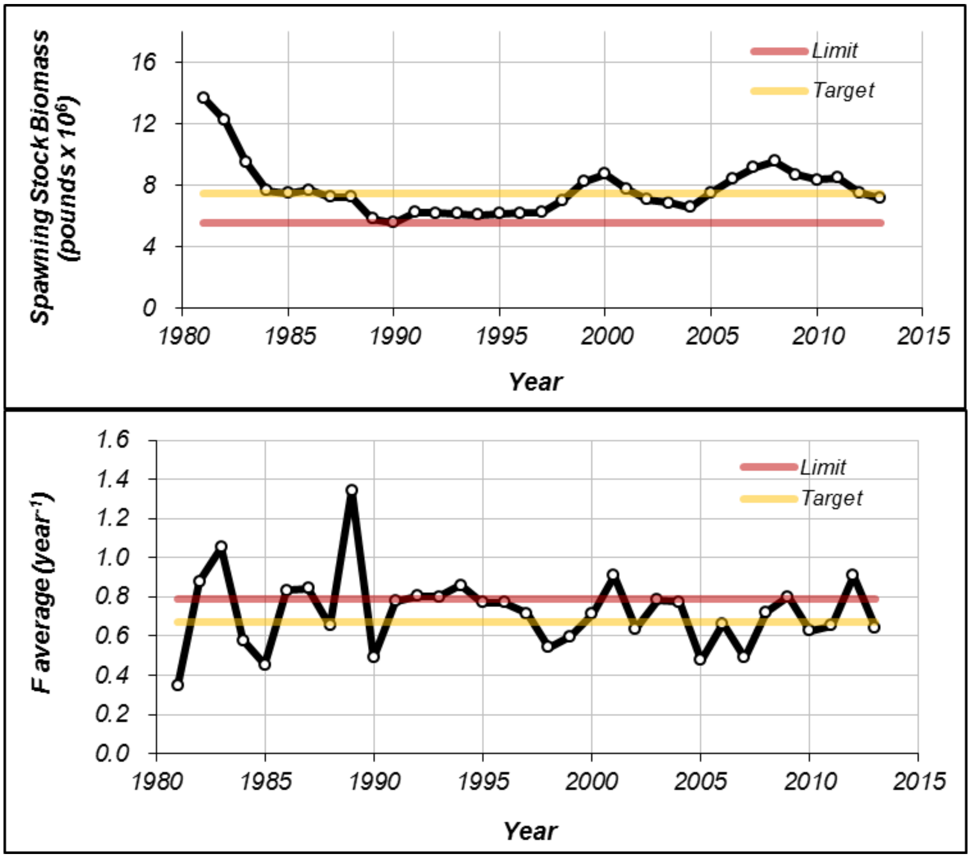

Figure 19: ASAP base model estimated age-1 recruits and female spawning stock biomass (open circles). Equilibrium recruitment is represented by the bold horizontal. Equilibrium recruitment per spawning stock biomass corresponding with the minimum and maximum spawning stock estimates and the median spawning stock biomass are represented by the slopes of the dashed diagonals (min. SSB=8%SPR; median SSB=11%; max. SSB=20%SPR).

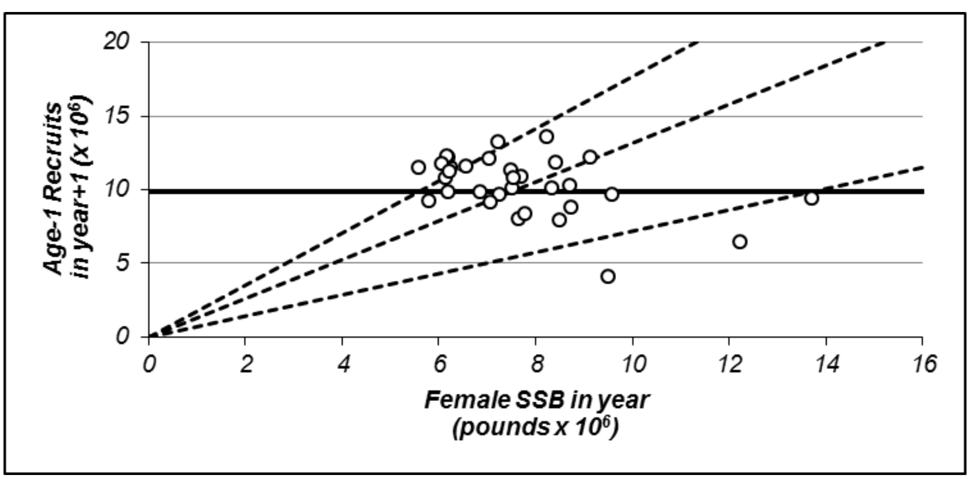

Figure 20: Retrospective analysis of ASAP base model. Top graphics depict annual average fishing mortality and female spawning stock biomass estimates. Bottom graphic depicts estimated age-1 recruits.

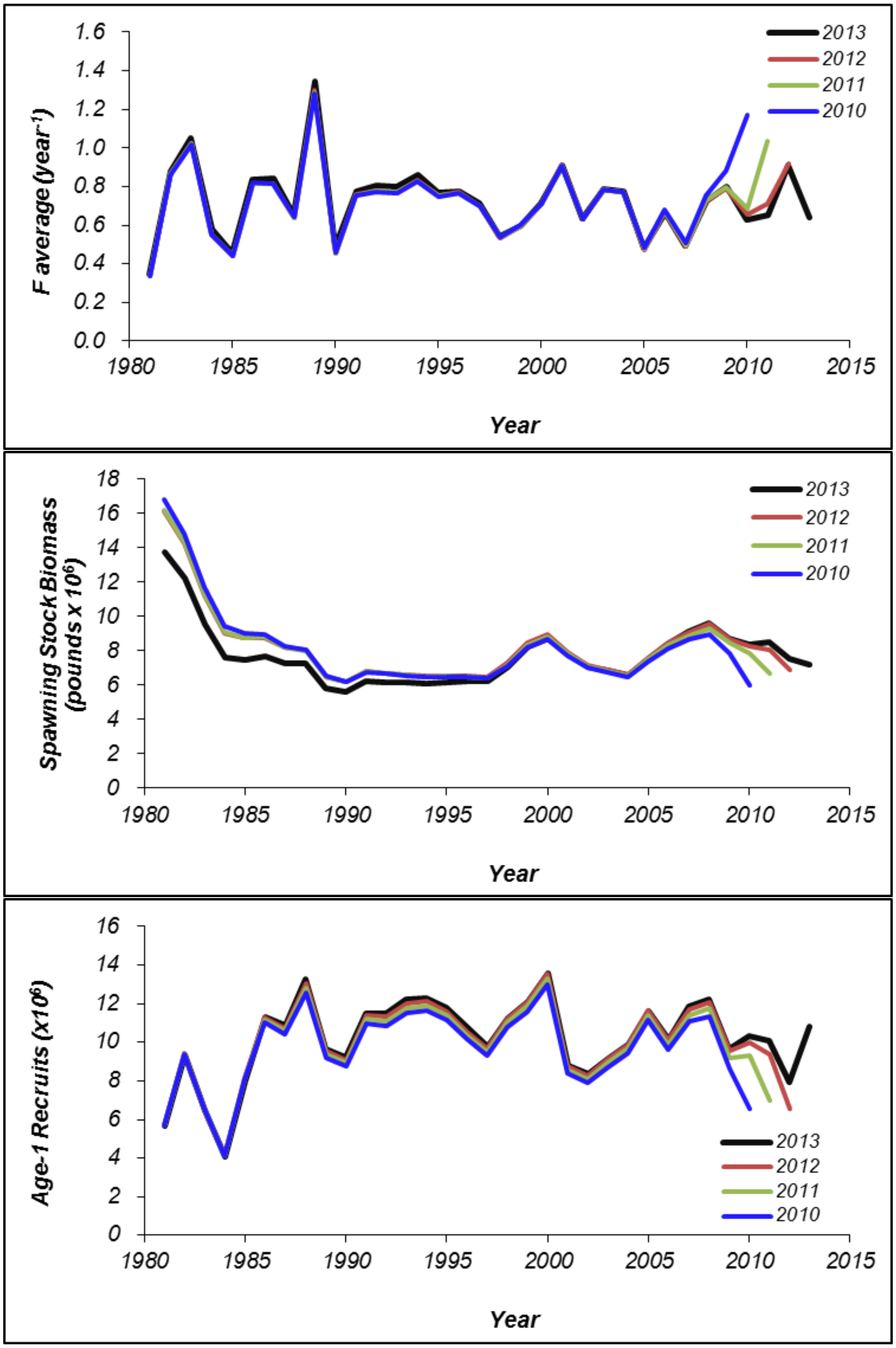

Figure 21: ASAP base model estimated ratios of annual average fishing mortality rates and female spawning stock biomass to the proposed limit reference points (F_{limit} and SSB_{limit}). Also presented are the proposed target reference points (the yellow lines). Arrows and dashed line represent direction of time-series. The yellow circle represents current status (geometric mean 2011-2013). Bottom graphic depicts current status and results of 2000 MCMC simulations relative to proposed limit and target reference points.